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MR. JOHN FOWLER AND THE STEAM PLOUGH.

ALTHOUGH the steam plough cannot take rank among those inventions which, like the steam-engine and the electric telegraph, have revolutionized the world of mechanics, and helped forward to an extent that can hardly be estimated the march of civilization, it is yet entitled to take up no mean place among inventions that claim to have introduced economy into one of the oldest and most important sciences followed by mankind, and to have facilitated the triumph of mind over matter. The history of the plough would probably furnish the subject of as striking a record of mechanical progress as it would be possible to write. It is one of the oldest and most honoured appliances of which we have any knowledge. There is no absolute proof that "the grand old gardener and his wife" had a plough at work in the Garden of Eden; but as it was their lot, as it has since been that of all their posterity, to eat their bread by the sweat of their brow, there is strong presumptive evidence that the first plough—rude, crude, and elementary though it may have been—was used by Adam. The oldest tribes and monarchies of the world used and honoured the plough. The relics of antiquity exhibit ample traces of its importance in the land of the Pharaohs, and down through all the centuries that have passed away; while Egypt was giving place to Rome, and Rome became superseded in power and greatness by other monarchies, the plough occupied a place *sui generis* in human history, changing now and again in its form and feature, but otherwise unaltered and unalterable.

But, while the hand plough has an origin so remote as to be altogether beyond the possibility of discovery, the steam plough is quite a modern invention. Traces of attempts to effect the operation of moving the soil by a "mechanical process not dependent upon animal power" can be discovered in the early part of the seventeenth century—long before the steam-engine itself had been evolved from the matrix of the future. Similar endeavours were made during the first half of the eighteenth century; but it was not until 1770 that Mr. Richard L. Edgeworth patented an engine with an "endless railway," described by a contemporary writer as almost identical with that well-known machine introduced by the late Mr. Boydell. One of the first distinct propositions for utilization of steam in the cultivation of the soil was made by James Watt, the inventor of the steam-engine. Watt, however, did not publish any details of his proposed invention, contenting himself with simply taking out a patent, vaguely designed for the application of steam to cultivating the soil; and we have no evidence that his ideas on the subject ever took a more practical shape. In 1832 a patent was taken out by Mr. Heathcote "for certain new and improved methods for draining and cultivating land, and new machinery and apparatus applicable thereto." In the construction of this implement Mr. Heathcote received considerable assistance from Mr. Josiah Parkes, and the plough really appears to have been a great advance on any implement of the kind that had preceded it; but, although it was put in competition for the prize offered by the Highland Agricultural Society at their Dumfries Show in 1837, it failed, from certain mechanical drawbacks, to receive the guerdon of merit.

From this date, the inventive faculties of agriculturists were stimulated to devise some more easy and effectual mode of tilling the soil, and many minds were directed to solve the problem of steam ploughing—efforts in this direction receiving a

still further impetus from the encouragement and facilities offered thereto by the leading agricultural societies of England and Scotland.

In 1849 a Berkshire agriculturist named Hannam brought out a steam plough, which had been constructed for him by Messrs. Barrett and Exall. This plough may be said to have marked another epoch of improvement, inasmuch as Mr. Hannam's was the first attempt to work a gang of ploughs by the ordinary engine, while it has also been put forward as the first endeavour to plough the land by wire traction ropes, worked by the engine from a distant part of the field.

In the Great Exhibition of 1851 there was a detailed plan showing the mode of applying steam power to ploughs which had been introduced on some of the Lincolnshire farms of Lord Willoughby d'Eresby. This nobleman bestowed a great deal of pains on the attempt to make steam ploughing a complete success, and the ploughs with which his name is associated were constructed on the turnwrist principle, being simply reversed on arriving at the end of their furrow. The engine was stationed in the centre of the field to be ploughed, and anchors were carried out to each headland, between which and the engine the gang of ploughs, attached to an iron frame, were drawn backwards and forwards.

After Lord Willoughby, the Marquis of Tweedale, a noted and advanced Scotch agriculturist, came into the race with a steam plough requiring the use of two engines, one on each headland, the plough frame being drawn from one to the other, and stirring the land it traversed to a great depth.

The next in the order of time to follow the Marquis of Tweedale was Mr. Usher, of Edinburgh. This gentleman devised a "locomotive engine," to the hind part of which a movable skeleton drum was attached, carrying on its outer circumference a set of four or five plough breasts, each covering a space of ten inches, and being arranged in a spiral form round the cylinder, so that each plough followed behind the other, taking a different cut of the same width, and effecting the ploughing or reversing of the surface in a diagonal line. This skeleton drum was driven round at a slow speed from the spur wheel of the engine, and, by working against the soil at the rear, propelled the machine along in a straight line. The engine was of a light tubular form, with a pair of fore carrying and turning wheels, but constructed with a broad iron roller instead of wheels behind, by which increased friction was obtained, while the pressure per square inch of the engine on the soil, by being distributed over a greater surface, was materially lessened.

Up to this time, in all attempts made to solve the problem of steam ploughing, the invariable principle adopted, although more or less varied, was that of attaching the propelling power to the implement in the form of a traction engine, and thus making it pull the plough like a horse.

Within the last two or three years the employment of traction engines with india-rubber wheels has led again to an attempt at moving the implement by direct action; but, like all previous efforts in the same direction, it has been a failure, because of the enormous loss of power, which is unavoidable if the engine is to travel over the land.

Agriculturists will remember that a machine on this principle commonly called the "rotary locomotive,"—the invention of Mr. Romaine,—has from time to time appeared at the meetings of the Royal Agricultural Society; and although at the Leeds Show of that Society, in 1861, it was declared by the judges "that the work done, though but little, was certainly the best in the field, the soil being finely pulverized to the depth of seven inches," the cost of the work in the consumption of fuel, and the wear and tear of the materials appear to have raised the cost far beyond the value of the work done.

The first practical solution of the problem of steam ploughing may be said to have been made in 1852, when Mr. John Fowler, then of Bristol, constructed his draining plough, which was moved by common hemp ropes. That gentleman shortly afterwards employed wire ropes to effect the movement of the common plough.

About this time, also, Mr. Smith, of Wolston, and Mr. Howard, of Bedford, took up the same system of ploughing, which was subsequently known by the name of the round-about tackle, and which is still used where common portable engines and small ploughs require to be employed.

Mr. John Fowler belonged to a Quaker family who had long resided in the neighbourhood of Bristol. He was brought up to mechanical pursuits, and early in life commenced business as an iron founder along with a gentleman named Fry—the style of the firm being Fowler and Fry. While so engaged, his mind was somehow attracted to the question of the drainage and cultivation of the soil. He undertook a contract for the draining of Hainault Forest, near Romford, and it was while engaged in this important work that he brought out his patent drainage plough.

Finding, however, that the economical application of steam to the cultivation of the soil was yet a desideratum, Mr. Fowler henceforth applied all his energies to supply the want—a want which many minds were simultaneously endeavouring to meet from many different directions. He had no works of his own suited to the purpose of manufacturing steam ploughs and testing their powers and requirements. Facilities for this purpose were, however, afforded him by well-known firms in different parts of the country, who took an interest in his labours and sought to aid in their fruition. Some of his experimental appliances were made at the famous agricultural implement works of Ransome and Sims, at Ipswich. Others were made and tested at the historical establishment of George and Robert Stephenson, at Newcastle-on-Tyne. The latter interest was obtained for Mr. Fowler by his father-in-law, the late Mr. Joseph Pease, of Darlington, who was associated with the Stephensons in the construction of the Stockton and Darlington Railway—the first passenger line opened in England. It was proposed to Mr. Robert Stephenson that he should take up Mr. Fowler's plans, and adapt his works for carrying them out. This Mr. Stephenson declined to do, on the ground that he was far too advanced in life to take a personally active part in new enterprises, but, in fulfilment of his promise to afford all the assistance in his power, he introduced Mr. Fowler to Mr. Jeremiah Head (now of Fox, Head, and Company, Middlesborough), and these two gentlemen henceforward applied themselves assiduously to the work in hand, until they succeeded in producing, at the Messrs. Stephensons' works, a plough which fulfilled all the conditions laid down by the Royal Agricultural Society, and received at their Chester Show in 1858 the prize of £500, offered "for a steam cultivator that shall in the most efficient manner turn over the soil, and be an economic substitute for the plough or the spade."

There were on this occasion no fewer than five competitors. One of the five ploughs, the invention of a Mr. Rickett, was constructed on the rotary principle, and was said to contain elements of promise, but it never again was heard of.

The judges who reported upon the trials of the competing implements stated that it had been proved beyond question that Fowler's machine was capable of turning over the soil in an efficient manner at a saving, as compared with horse labour, on the light descriptions of land, of from 2½ to 25 per cent.; and in trenching, of from 80 to 85 per cent.; while the soil in all cases was left in a far more desirable condition, and better adapted for all the purposes of husbandry. The report continued to state that "these money results, satisfactory though they be, are not, we consider, the only points of advantage which the introduction of these machines confers upon agriculture. By their aid we can carry out a system of autumnal cultivation now so universally admitted to be desirable, but which it is extremely difficult to effect with the ordinary force of a farm in ordinary seasons and under ordinary circumstances. We can continue our cultivation, by ploughing or otherwise, well-nigh regardless of weather, and upon land which would not bear the pressure of horse labour. We have perfect control over the work we wish to have done; and when it is done it is found to be more regular throughout, and to be done in a more open and desirable condition than could be obtained by the best and most judicious application of the ordinary implements of a farm."

It may be remarked that although this was undoubtedly the greatest triumph achieved up to this time by Fowler's plough, it was not the first. The gold medal was awarded to Mr. Fowler at the French Agricultural Exhibition in 1856, and at the Stirling Show of the Highland Agricultural Society in 1857 he carried off the prize of £200, offered for the best steam cultivating machinery.

The success of Fowler's plough at the Chester Show of the Royal Society in 1858 was followed by numerous additional victories in the same year, including the Yorkshire Agricultural Society's prize at Northallerton, Lord Bolton's special prize at the same meeting, the prize offered at the Londonderry meeting of the Royal Agricultural Improvement Society of Ireland, and the Scotch Farmers' prize at the Stirling meeting. The chief prize offered at the Royal Society's Show held at Warwick in 1859 again fell to Mr. Fowler, although there were several competitive exhibitors, and in that year also the Fowler plough carried off the prize awarded at the Ashford Show of the Kent Agricultural Society.

Public interest had now been thoroughly aroused on the subject of steam cultivation, and in the agricultural world it was the subject of the hour. The Royal Society offered another prize, of £90, at their Canterbury Show in 1860, and five competitors again entered the field, who were, however, quickly reduced to two. A more severe and crucial test of the capabilities of the various implements entered for competition was made on this occasion. Three days' work in the first set of

trials, "on a moderately strong loam, having an indurated gravelly subsoil, the surface strongly bound together by the growth of indigenous herbage," showed that the land was efficiently ploughed by Fowler at the rate of 4*s.* 6*d.* per acre; and by Robey and Co. at the rate of 6*s.* 8*d.* per acre; while the dynamometer attached to one of Busby's iron ploughs, drawn by the wire rope, showed an average draught or resistance in the 7 × 10-in. furrow-slice of 692·32 lbs., more than equal to the force of four good horses moving at the rate of 2½ miles per hour. This average draught was calculated at a minimum of 12*s.* per acre.

A second set of trials took place on some adjoining land, where the soil of a similar character had not been moved for many years, and where the inclination or slope of the land was so great—having an average gradient of one in ten, and in the steepest parts one in four—as to render it impossible to touch it with horse labour, except in a diagonal direction. The draught of the furrow-slice, tried in the same way as before, showed an average resistance of 1,298 lbs., equivalent to the traction power of eight horses. It was calculated that this would cost at least 24*s.* per acre; and the estimates for the work done, given by the practical farmers on the field, were from 30*s.* to 36*s.* per acre, though it was admittedly impossible for horse labour to have turned the same furrow at any cost. It was shown, however, that Fowler's plough did the work efficiently at the rate of six acres per day of ten hours, and at a cost, including everything, of 8*s.* 4*d.* per acre; while Robey and Co's plough worked at the rate of 3⅓ acres per day of the same length, and at a cost of 11*s.* 8*d.* per acre. The judges reported that throughout the whole of the trials the quality of the work done was very satisfactory, and in an appendix to their report they recommended that the future trials of steam ploughs should be of more prolonged duration, in order to give them that practical value which can alone satisfy the public as to the great advantage they possess.

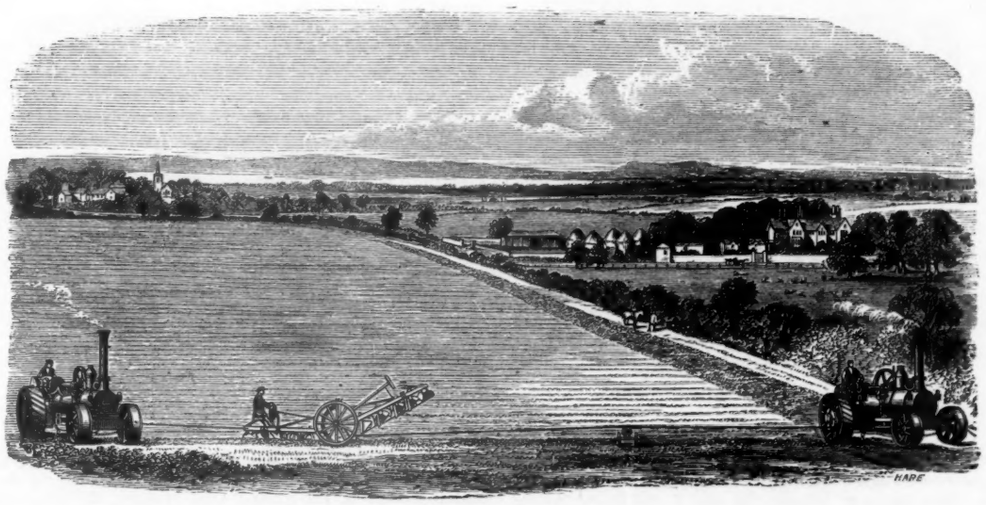


Fig. 1.

Up to this time Mr. Fowler's ploughs had been worked on what is known as the direct principle, by the application of a single engine and a moving anchor. This tackle was subsequently improved by Mr. Burton's (of Leeds) invention of the clip drum, and in 1860 it was considered the best steam plough that could be produced. But Mr. Fowler was not satisfied with what he had already achieved, and in the year of the Leeds Show of the Royal Society in 1861 he brought out his first double-engine tackle, which has given to steam cultivation an altogether surprising impetus, and facilitated its adoption, not only in England, where every encouragement is given to mechanical improvements, but also on the Continent and elsewhere abroad.

The Council of the Royal Society, in offering a prize of £100 for the best steam cultivating machinery, at their Leeds Show in 1861, arranged to keep the competitive ploughs in the trial fields long enough to show whether they could, on a prolonged trial, sustain the character they had achieved at former meetings for excellence and economy of work. Report was made by the judges, after most careful and elaborate experiments, that on the heavy land the ploughing was done for 7*s.* 10*d.*, and the scarifying for 7*s.* 2*d.* per acre by Fowler; and at the rate of 17*s.* 2*d.* for ploughing, and 6*s.* 8*d.* per acre for scarifying by Howard—these being the only two out of five competitors that submitted to the tests imposed. The results of the work done on light land, where the tackle was attached to and driven by an ordinary portable engine, showed that Fowler grubbed the clover by 7 in. deep at a cost of 6*s.* 6*d.* per acre; while Howard did the same work 5½ in. deep at a cost of 5*s.* 3*d.* per acre. On the heavy land, again, the clover and rye grass was worked by Fowler's grubber 8 in. deep at a cost of 6*s.* 9*d.* per acre; while Howard's tackle grubbed it 5½ in. deep at a cost of 6*s.* 2*d.* per acre. The land selected for the trials was described by the judges as being in every respect well suited for the purpose. It was so far varied in character as fully to test the power of the engines, the strength of the tackle and implements, and the suitability of the latter for the various operations by which the tillage of the soil is effected. The prize of £100 was not only awarded to Fowler's plough, but that gentleman also carried away another prize of £75, which was offered "for the best set of apparatus to be worked by ordinary portable engines."

It may truly be said that from this time forward the steam cultivating machinery of Mr. Fowler pursued a career of uninterrupted triumph. In 1861 it received the gold medal at the general meeting of the German Agriculturists and Foresters, held at Schwerin, Mecklenburg-Schwerin, and in April of the following year it was awarded the gold medal of the Ayrshire Agricultural Society.

Fowler's was one of nine steam ploughs entered for competition in the International Exhibition, held in London in May, 1862, the other exhibitors being Chandler, Coleman, Halket, Hensman and Sons, Howard, Leach, Robey and Co., and Steevens. Each of these ploughs was described as being "on the traction principle, where the engine is stationary and the power is conveyed to the implement used through a wire rope. They differ, however, widely in the mode in which the power is applied, and also in the nature, form, and construction of the different implements used for effecting the object they all have in view—namely, the inversion of the soil operated on." Fowler's apparatus was again admitted to be the most advanced and perfect, and received the gold medal awarded in this competition.

From first to last Fowler's steam cultivating machinery has been awarded over a hundred different prizes and certificates of merit in public competition. It has been the recipient of prizes, either in money or in the form of medals and cups, from every leading agricultural society in the United Kingdom, and at the last and most important trial of steam cultivating machinery, held at Wolverhampton in 1871, under the auspices of the Royal Agricultural Society, it received in all no less than thirteen prizes, including a gold cup, offered by the Right Hon. Lord Vernon, President, for the best combination of machinery for the cultivation of the soil by steam power, the cost of which shall not exceed £700; the engine to be locomotive, and adapted

for threshing and other farm purposes. But it is not alone within the limits of the United Kingdom that Fowler's machinery has been successful. It has received numerous testimonials in nearly every part of the world, including the first prize of the Hamburg International Agricultural Society in 1863; the Bengal Agricultural Society's prize at Alipore, Calcutta, January, 1864, for the best steam cultivating apparatus, 500 rupees; the gold medal as prize of honour of the Pomeranian Agricultural Society, at the Universal Exhibition at Stettin, May, 1865, and the prize of 500 thalers for the best steam plough. The prize of 150 friedhs. d'or, at the International Exhibition at Cologne, for the steam plough, in June, 1865, and the prize of 500 thalers for the best traction engine; the gold medal at the French Universal Exhibition, in August, 1867; the Louisiana (U. S.) State Fair premium diploma and first prize, February, 1868, "for the best traction or locomotive steam engine for farm or plantation use, adapted to all purposes;" and the premium diploma and first prize "for the best practical working arrangement of gang ploughs, for breaking up and preparing ground for planting, to be drawn by steam power;" the gold cup offered by his Highness the Viceroy of Egypt at the Royal Agricultural Society's Meeting at Leicester, July, 1868, "for the best implement for the cultivation of the soil by steam power, combining strength with simplicity of construction, for use in foreign countries where skilled

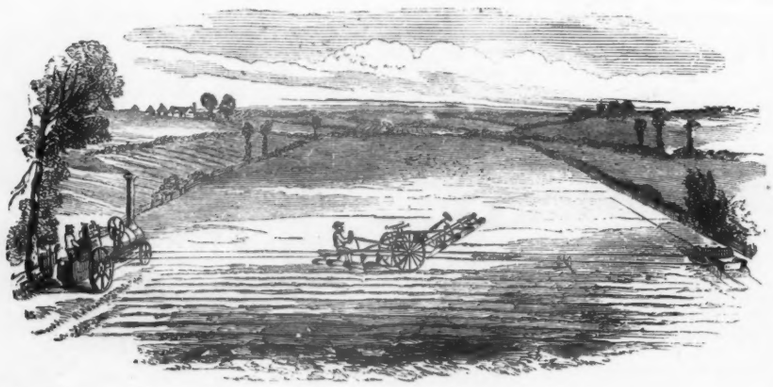


Fig. 2.

labour for repairs is difficult to be procured," valued at £200; the highest award of the International Exhibition held at Vienna in 1873—the diploma of honour—for steam cultivating machinery; the medal of progress offered at the same Exhibition for traction engines; and the first prizes offered at the International Exhibition held at Bremen in June, 1874, for the best steam cultivating apparatus, and for the best steam plough for reclaiming waste land.

As good wine needs no bush, so nothing need be said by way of eulogy on the machinery with which the name of Fowler is identified; but it will now be well to describe briefly the various systems of steam tackle manufactured by Fowler's firm, in their most perfect form.

There are four different systems, each adapted more than any of the three to certain exigencies and situations. In the first system the tackle used consists of two self-moving engines with winding drums, 800 yards of Fowler's best hard steel rope, and ten rope porters. The plan of working—which we illustrate in fig. 1—may be thus described. Two winding engines are worked on opposite headlands, and each alternately draws the implement towards itself, the engine not in work paying out the rope while moving forward into position for the return journey. Any kind of implement may be used. It is claimed that one of the principal advantages of this system is the facility with which the machine is set to work and taken up. The engines are ready to start into a fresh field the moment they have stopped work, and remove themselves and the whole of the apparatus without any additional manual or animal labour. Where fields are small or very irregular, or where, as frequently in foreign countries, the steam plough cannot depend on any prompt assistance for removals, or where the distance between the fields which have to be worked is considerable, this handiness for moving about is evidently of great importance.

A further advantage of this system is the possibility of using implements of large size which could not be moved from field to field by any apparatus not self-moving. For the cultivation of light land, which, in an economical point of view, is only practicable by employing implements of the greatest possible breadth, this system is invaluable. The fact that it will do from thirty to fifty acres' regular work per day on the lighter class of soils, at once establishes its superiority over any other class of machinery for that purpose.

In the second system (fig. 2) the tackle consists of a self-moving engine with clip drum, windlass, anchor, 800 yards of Fowler's hard steel rope, twenty rope porters or carriers, and snatchblock, with headland rope for pulling the tackle forward.

On the left headland is the engine, and directly opposite to it the anchor. Both move gradually forward along the headlands, and between them the plough or other implement is pulled backward and forward, one end of it being alternately in the air and the other in the ground, thus avoiding the necessity for turning. The implements are constructed with patent slack gear, which lengthens or shortens the ropes as the boundary of the field may require, and at the same time, without any loss of power, keeps both ropes sufficiently tight to prevent them from trailing on the ground (if properly "portered"). Any class of implement may be used that can be fitted with "slack gear."

The winding apparatus attached to the engine used to actuate this tackle is somewhat remarkable. The windlass consists of a single sheave 5 ft. in diameter, round which the rope takes *half* a turn; the groove into which the rope passes is formed of a double series of small clips, which on the least pressure clasp and hold the rope until it takes the straight line on the other side, when they freely open and liberate it. By this simple appliance all crushing and short bends, which are so detrimental to the profitable use of wire rope, are entirely avoided, the rope being only bent twice on each passage of the implement, and then round large diameters. The clips are made of chilled cast-iron, which is not liable to much wear, but when worn can be replaced at a trifling cost. Clip-drum engines for this system are made of 12 and 14-horse power; they can at any time be used for traction purposes, and are also specially adapted for threshing, pumping, sawing, or any other work for which portable engines are suitable. In this process a patent anchor is used, in the shape of a wrought-iron frame carrying a horizontal sheave resting on thin disc wheels, which cut into the ground, and resist the side strain of the engine and implement. It is moved along the headland by the motion of the sheave or pulley, which is turned by the rope; the sheave is connected by gear to a drum, which winds up a rope stretched along the headland, thusk eeping the anchor opposite its work. The apparatus is provided with a steerage, which enables it to be worked along a crooked headland; and it is managed by a boy, who also attends to shifting rope porters. The box at the back is intended as a counterpoise, to prevent the anchor from being pulled over when doing very heavy work.

The third system may be described as a modification of the first and second. The engine is constructed so as either to work along the headland with an anchor, &c., having a direct pull upon the implement (as in the second system), or to stand in a corner of a field and work the tackle with the addition of the snatchblocks. This system is more particularly recommended where the amount of capital available is not sufficient for the purchase of the first system.

In the fourth and last system a cheap tackle is made use of, adapted to be worked by an ordinary portable or traction

engine. It is quite strong enough to take the power of a 10-horse power engine through it. All the loose parts which are employed in tackles manufactured by other makers are dispensed with in this, consequently it can be removed and fixed in position again in less time than any roundabout tackle. The tackle consists of a new patent detached winding windlass, with patent self-acting coiling gear, two 4-disc anchors, each fitted with 80 yards of rope for moving forward on headland, four claw anchors, 1,400 yards of rope, two large 4-wheel rope porters, ten small rope porters, and universal joint for coupling windlass to engine. One of the new patent 5-tyne turning cultivators is made for this tackle. No double snatchblock is required, as the coiling gear admits of the rope being paid off at any angle. The plan of working is described as being in one respect different from any hitherto proposed. The engine and windlass being placed on one headland, the anchors are let down at the two ends of the same side of the field. The rope being pulled, out the work begins at once along the same headland, the anchors working gradually away from the engine. This gives in starting the advantage of having little rope to pull out, and dispenses with bringing anchors and snatchblocks into the remotest corners of the field. It also secures the peculiar action of the ropes on the anchors, by which the anchor is kept

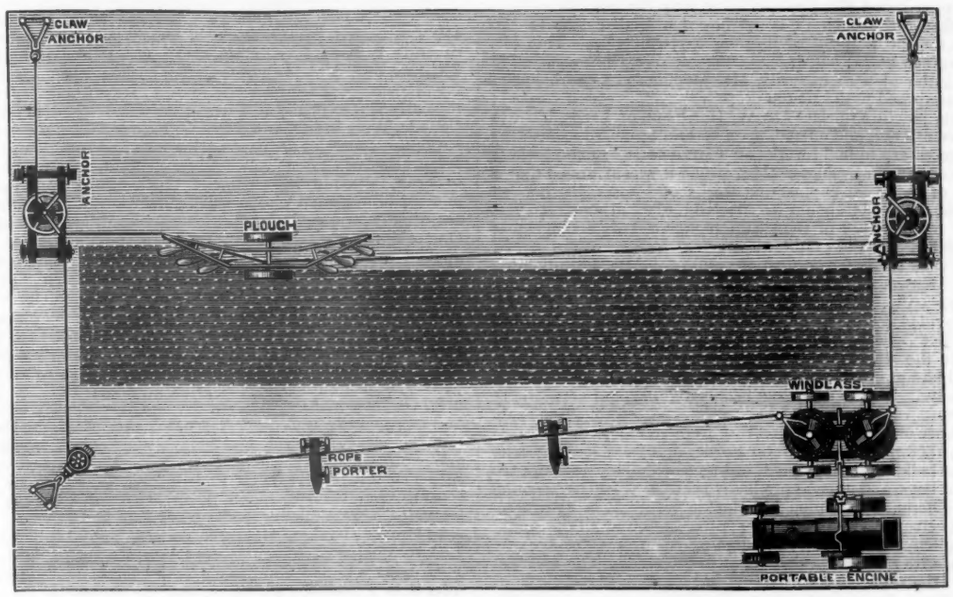


Fig. 3.

rigidly fixed between the ploughing rope and the winding forward rope; while it finally secures perfect coiling, as no slackness is occasioned by the movement of the anchors, and with every journey of the implement the quantity of rope on the drums necessarily decreases. After finishing the ploughing between the two headlands, the tackle is in a position to plough the headlands without any removal of its parts, after which anchors and implement can be hauled back to the windlass by the ploughing rope, thus clearing the field of all the tackle without the assistance of horses. Two men can work this tackle. It is advisable, however, to engage a boy to assist the ploughman at the headlands and look after the rope.

These four different classes of tackle have been manufactured, because it has been found, from careful observation of the practical working of steam cultivating machinery during a series of years, that it is impossible for any single system to work with equal advantage under all circumstances.

With a view to the economical working of steam ploughing machinery, Messrs. John Fowler and Co. state, "We consider the following principles to be essential: the direct pull on the implement without interference of pulleys and snatchblocks; the use of the smallest possible amount of wire rope; great facility for moving the machinery from field to field; and the employment of a minimum of manual labour. In three of the described systems, but especially in the first, these conditions are fulfilled in the most complete manner. The horizontal position of the winding drum permits the working of the rope at any angle required by the direction of the furrow, and the engine, with the complete winding apparatus attached to it, is at any moment ready to move itself and implements from field to field. In the case of small holdings, where the fields, generally small, require frequent removals, it is essential that the machinery should be self-moving, and of the most compact description. Such holdings are scarcely able to employ the staff of men required for the working of any system, and the employment of steam in such cases will not always repay the outlay absolutely necessary even for a small apparatus. We have, therefore, come to the conclusion (fully borne out by the experience of the last seven years) that the proper way of working steam cultivation on small farms is for a number of farmers to combine for this purpose, and employ the best machinery of large size."

Messrs. Fowler and Co. declare that, "after eighteen years' experience, including carefully conducted experiments under the most varied conditions, we have come to the conclusion that steel wire rope is the only practicable medium of communication between the engine and the implement. The proper laying out of land on which steam cultivation has to be employed is of the utmost importance for its final success. The expenses of cultivation may, by using judgment in this respect, be reduced by more than one-half on a well-laid-out estate compared with an irregular holding. Independently of the advantages to be gained by the use of steam power, the clearing out of old fences and trees will be a source of profit to the farmer, as they harbour vermin and debar the progress of profitable agriculture. In estimating the expense of steam cultivation, there are few who justly appreciate the great change that it effects in the character of the soil, both as regards the drainage and the cost of after-tillage. It is quite evident that, when land has been once thoroughly broken up by steam, every succeeding operation requires less power to effect it; and the experience of those who use steam power proves that but one-half the number of these after operations is required, mainly because the work is more effectually done in every way."

The first cost of steam cultivating machinery is necessarily very expensive, and it is due to this fact, more than to anything else, that it has not made much greater progress. Messrs. Fowler and Co.'s estimate for a 20-horse power set of steam ploughing tackle—known as the double engine set—with all accessories, is £3,061 6s.; while a complete set of 12-horse power steam ploughing tackle is estimated to cost £2,034. The firm send out men to start machines in any part of the country, charging 25s. per week for their time, while the farmer finds board and lodgings, and pays all travelling expenses.

JOHN FOWLER AND CO.'S STEAM PLOUGH WORKS.

Reference has already been made to the fact that the first steam ploughs brought out successfully by Mr. Fowler were made at the chemical works of the Stephensons, at Newcastle-on-Tyne. It was by the merest accident—a trifle light as air—that the now world-famous steam plough works of Mr. Fowler, at Leeds, were not located in the capital of Tyneside. Mr. Robert Stephenson, on seeing that the steam plough in Mr. Fowler's hands was likely to prove successful both commercially and mechanically, suggested that works should be built in Newcastle for its manufacture, and offered, in that case, to advance £3,000 to Mr. Jeremiah Head—a gentleman already alluded to as having assisted Mr. Fowler in carrying out his plans—provided that Mr. Joseph Pease advanced a similar sum to Mr. Fowler for the purpose of forming a partnership. This Mr. Pease agreed to do; but, as some unavoidable delay occurred in bringing the plan to maturity, Mr. Stephenson's death meanwhile interposed to thwart the project.

At this juncture the late Mr. W. Hewitson, of Leeds, came to Mr. Fowler's aid, and offered, upon certain terms, to furnish the funds necessary to build works on a large scale at Leeds, where he himself was in business. Meanwhile it was arranged that a branch of the large engineering works of Messrs. Kitson and Hewitson, in Leeds, should be specially adapted and set apart for the manufacture of the steam plough. This arrangement continued in operation until 1860, when the new works of Mr. Fowler were ready for occupation, and of course the adjoining works of Kitson and Hewitson were then vacated.

As originally constructed, the works of John Fowler and Co. only provided for the employment of from 200 to 250 men and boys. But between 1861 and 1864 an immense impetus was given to the development of the steam plough. The home demand had gradually improved, and very large orders came in from abroad. Hence it became necessary to extend very largely the productive resources of the works, and within three years the number of hands employed rose from 200 to 900.

Since 1868 the works of John Fowler and Co. have gradually grown in bulk, until they now afford regular employment to 1300 men and boys, and possess productive resources equal to turning out six different sets of ploughing tackle per week, being equivalent to twelve engines of 20-horse power each, and all the accessory implements—including ploughing apparatus, windlasses, anchors, wire ropes, &c.—belonging to the tackle. The arrangements of the works are carried out in such a manner as secures a high, if not the highest, attainable degree of order and efficiency. The firm make all their own forgings, the iron they use being principally the Low Moor, Bowling, and other standard Yorkshire brands. The tool-shops are very extensive and complete, being furnished with a lot of special tools designed for the purpose of producing the different appliances belonging to steam cultivating machinery. The erecting-shops are also of vast extent, and appear to be chiefly remarkable for their abundant crane provision, whereby manual labour is reduced to the lowest practicable limits. The foundry is of recent erection, having been built only last year, and is justly regarded as a model of its kind, while it is sufficient to meet any reasonable extension of the other branches for years to come. Tramway lines intersect the works from one end to the other, and a splendid suite of offices is built at the entrance, which appears to be as jealously guarded from intruders as the golden apples of the Hesperides—no one being admitted, except in company with one of the "men having authority" or a written order.

THE AMERICAN ASBESTOS INDUSTRY.

THE power of asbestos to resist the action of intense heat has been known from ancient times, and, although numerous attempts have been made to work this material up into fabrics capable of resisting the action of fire, nothing of any definite value has ever resulted from such experiments until within the last quarter of a century. Within the period named it has been discovered that asbestos, made to adhere to the surface of pipes and boilers by means of suitable cement, is one of the very best non-radiators, whilst at the same time it is capable of resisting, for any length of time required, the action of the heat to which it is subjected. It has also been applied to roofing purposes with great success. These applications have been due to the persistent ingenuity of American inventors. Asbestos contains more valuable properties in its application to boilers or pipes as a non-radiator than any other material known. It is strong, adhesive, incombustible, and so elastic that it does not crack by the action of expansion and contraction. It is very easily applied, and a firm, compact, smooth, and indestructible covering is produced, which combines the very highest non-radiating power with elegance of appearance. There are a number of competing establishments, which manufacture and apply asbestos to boilers and pipes. None of these, however, have exceeded, if they have ever approached, in extent of their business or in the excellence of their wares, the Asbestos Felting Company, Nos. 316 to 322, Front Street, New York, whose facilities partly rest on the ownership of extensive mines of asbestos in Virginia. The processes of preparation are, we believe, entirely original with the company, though a great many worthless imitations of the articles they manufacture have been produced. They can manufacture upwards of 300 barrels of asbestos cement per diem. This cement has been applied as a covering to boilers and pipes to an extent almost incredible, when we consider the short time that has elapsed since this useful preparation was first made known to the public. It is now regularly sent to nearly all parts of the world—the United States, Canada, West Indies, and England, France, Germany, and other European countries demanding large and increasing quantities. It has also been extensively used for the protection of the boilers of ocean, lake, and river steamers. The company employs a large number of workmen who are skilled in applying the felting, and are usually sent to put on the covering for those who order it. One of the greatest advantages of the material is that it can be applied to boilers while hot, and it has often been applied on steamers while making their trips on the Mississippi, Ohio, and other rivers. Three coats are usually employed, forming together a thickness of 1¼ in. The finishing coat leaves a hard, smooth, waterproof surface, which has the appearance of fine plastering. The cement is used in combination with a peculiar kind of fireproof felting manufactured by the company at another branch of their works, near Elizabeth, New Jersey.

As the merits of the material become more known, it is more and more widely used. During the last four years, the Remington Armoury at Ilion has ordered the covering six times for application to boilers and pipes to be put up in extension of these celebrated works. At Philadelphia, the City Poor House is using over 25,000 ft. The company is now applying the covering to the large steamers on the Havannah line.

In Drexel's Banking House, corner of Wall and Broad Streets, 3,000 ft. of pipe have been covered with it. Several of the large sugar-houses in and about New York have been experimenting with it as a covering for tanks, and the success of the experiments indicates that it will be extensively used for that purpose. Messrs. Ockerhausen and Brothers are now using it on several of their largest tanks. Another extensive order which the company are now filling in is the covering of miles of pipes at Barren Island for the Fertilizing Company, whose works are there located,—a very extensive concern. The extensive abattoir at Hackensack, New Jersey, uses the covering on all the tanks and pipes. The new water-works at Long Island have all their pipes overlaid with it.

The company are now covering the pipes and boilers of steamers in a very improved manner. Mr. Cornell, in Roudout, has the boilers of his steamer "Columbia" covered with three-quarters asbestos-cement and one-quarter improved hair-felt, and intends to have all the boilers on the line covered with the same material. The Delaware and Hudson Canal Company have the boilers and pipes in their boats all covered in the same way.—*American Artizan.*

THE CASSON-DORMOY PUDDLING FURNACE.

THE illustration on next page represents a puddling furnace that has been working most successfully for nearly three years at the Earl of Dudley's Round Oak Iron Works and elsewhere, effecting a saving of from 40 to 60 per cent. in coal, fettling, bricks, castings, &c., &c., and at the same time increasing the output 200 per cent., whilst improving the quality of iron made.

It may be described as a combination of four patents taken out by Mr. R. Smith Casson, of Brierley Hill, and Mr. P. A. Dormoy, of France, the power to grant licences resting exclusively in the hands of the former gentleman.

The furnace differs from the old system :—

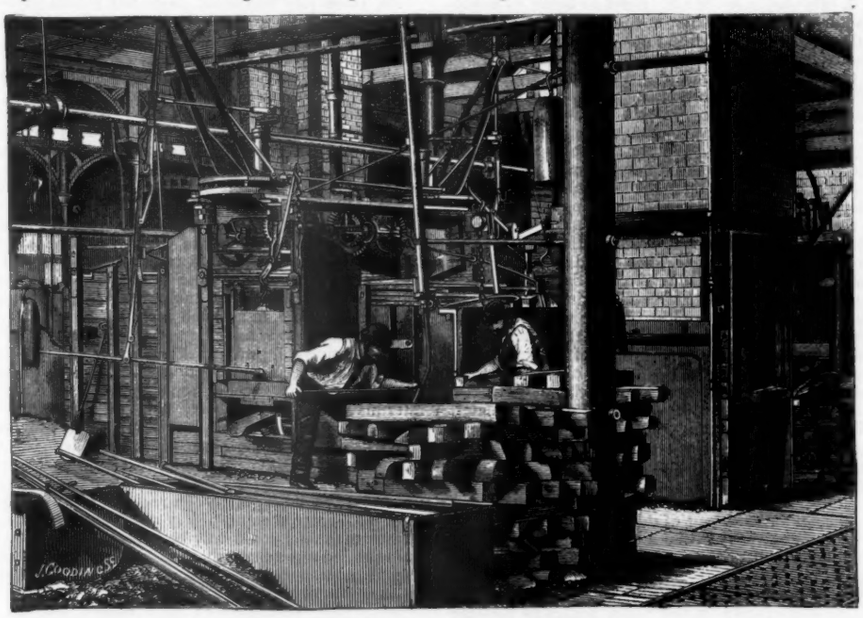
1st. In having a puddling cast-iron basin with sloping sides, and bolted together with wrought-iron bolts, the said basin resting upon a wrought-iron open water dish in such a manner as to allow steam to be generated from the heat of the basin,

so as to cool the bottom and sides of the puddling basin, thus protecting the plates and fettling from the action of the fire.

2nd. In having a heating chamber between the puddling basin and stack, and serving as a neck to the furnace, the waste flame being thus utilized to heat the pig iron to a condition of incipient fusion, whereas formerly the pigs were thrown cold into the puddling chamber.

3rd. In having wrought-iron "screens" each side of the doors fixed so that a stream of cold air can pass between them and the furnace, to protect the puddlers from the heat of the furnace. The fire grate may be the same as with the ordinary furnace, but improvements in this are being made and patented by Mr. Smith Casson to enable inferior coal or slack to be used, at the same time giving to the workmen more control over the heat and condition of the gases.

Owing to the peculiar construction of the basin, no casing plates are needed; consequently the outside walls are merely built with red bricks supported by old rails as buckstaffs, &c. Mechanical puddling has often been tried, but with very doubtful success. This furnace, however, overcomes all the difficulties—first, because it is so constructed and maintained that the rabble travels over every inch of surface, leaving no corners that the machine cannot reach; and, secondly, because the heating chamber enables one-third more iron to be turned out,



THE CASSON-DORMOY PUDDLING FURNACE.

thus with a double furnace tripling the output of an ordinary single one.

The *modus operandi* is thus: as soon as the iron is melted the rabbles are attached to the machine, and puddling commences, and is continued until the iron drops, *i.e.*, when the cinder begins to separate from it. The machine is then stopped and the rabbles removed, and the puddler begins to "ball up" the iron. The cold "pigs" are then put into the heating chamber, a few being left out to be thrown in later. As soon as the balls are formed they are taken out and conveyed on "trolleys" to the hammer. The furnace is then tapped and fettled, and the hot pigs passed over the bridge, and in about one quarter of an hour they melt, and the process is repeated *de novo*.

In the old single furnace the charge consists of from 4 to 4½ cwt. In this it varies from 10 cwt. to one ton with the same number of charges per day if 10 or 12 cwt. are charged.

Below is a statement of six months' work with two "Casson-Dormoy" furnaces at the Weardale Iron and Coal Company's Works. Formerly their average of coal was about 27 cwt. per ton; from which it will be seen that with this furnace the average of fuel per ton of iron produced was only 12 cwt. 2 qrs. 21 lbs.

Remarks.	Charge.						Produce.				Yield.			Coals used.			Coals used per ton of iron made.		
	Pig and Plate.			Scrap.			Puddled Iron.			Scraps.									
	tons.	cwts.	qrs.	tons.	cwts.	qrs.	tons.	cwts.	qrs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	cwt.	qrs.	lbs.
All short weight.	3128	9	2	146	16	1	2840	5	0	98	10	1	1 2 0 3	1865	13	0	12	2	21

The Earl of Dudley has one forge almost entirely on this principle, and his lordship's manager is now reconstructing another forge, and is fixing tubular "boilers" over the machines, so as to raise all the steam necessary to drive the forge engines from the waste heat of the furnace.

PRACTICAL NOTES ON ECONOMIC MANUFACTURE.

RESUMING our remarks under this heading of "Transmission of Power from the Prime Motor to Mill machinery" (see May number of "Practical Magazine"), we may conclude this subject by a few observations on the "wear and tear" and the "economy" in belt driving.

Referring to the wear and tear in belts, a well-known writer on this subject says that he saw in an American factory a belt driving 140 horse-power from a drum 9 ft. in diameter, and going at the speed of 130 revolutions per minute and driving a shaft which had a drum of 7 ft. diameter upon it. The strap was 24 inches wide, of double leather sewn together. It was asserted that this strap had run for *seven* years without piecing or tightening, having been tightened only once since it was newly put on. Being surprised at this statement, further inquiry was made at different mills, which fully confirmed what had been said as to the durability and ease with which these large belts do their work. The forementioned writer observes on this: "If reflected upon, what an impressive lesson this teaches! How delightful it would be in a mill if all the straps would run so long without piecing or giving trouble! Yet so it would be were the same conditions observed." Comparing modern English practice with this, we often meet here carding engines with 12-in. main cylinders running at only 140 revolutions per minute, which is barely equal to 440 ft. per minute; that is to say, as the big belt above referred to travels at a speed of over 3,640 ft. per minute, we are here driving with only one-eighth the speed of our American cousins. We may therefore conclude that, in order to secure little wear and tear, and work with less power and steadier production, we should have very light shafting run at a very quick speed with larger drums and pulleys.

The preceding paragraph clearly shows the economy of belt-

driving, and we have therefore only to add that the simplest and best method of driving by belt, also the cheapest and most durable, is to convey the power from the main driving shaft direct to each room by a separate strap, and, if more than one shaft is wanted in any of the rooms, to drive it from the other direct by a separate strap. We have given the millowner a few words of advice in the economical transmission of power, and we now intend to take leave of him, in order to direct our attention to the soap-manufacturer in special. We take for our second subject

Glycerine and its Uses,

and although in this choice we do not intend to detail its economical manufacture, since the same is more or less known to every soap-boiler, yet it has occurred to us, from practical experience, that the manufacture of this important article is largely neglected by the class we are referring to, much to their own detriment and loss. We therefore intend to show to the soap-boiler what pecuniary gains he may effect by the conversion of what he may hitherto have treated as a waste product into a really valuable, saleable article. We shall best be able to impress on the soap-boiler's mind the importance of glycerine as a commercial article, by first referring to the manifold uses to which it may be applied, and shall, moreover, in so doing offer interesting matter to the general class of our readers.

Glycerine, or oil-sugar as it is sometimes called, was discovered by Scheele in 1779. It has a sweet taste and is of a yellow colour, without smell and uncrystallizable. It is contained in all oils and fats of the animal and vegetable kingdoms, and is likewise obtained as a secondary product in the manufacture of stearine candles. We may, however, observe that the use of sulphuric acid in the modern manufacture of these candles mostly destroys the glycerine, whereas in the older treatment the article under discussion was obtained in such weak solution as to be almost imperceptible with the use of the areometer. With the application of high steam pressure, this fatty solution, as it is often called in candle works, attains a strength of 5 to 6° B., and consequently this process may be looked upon as the most profitable in the manufacture of glycerine. These preceding remarks conclusively prove the presence of glycerine in a pure state in the soaping treatment of the soapy waters, and we may possibly infer its presence in the dissolved lime mixed up with the coloured and bad-smelling substances of the fatty matters employed. We conclude, from this, that glycerine is soluble in water and spirits of wine.

Since glycerine is contained in the soapy waters of stearine candle works, it must be extracted from the salt bases, which is done by neutralization, distillation, &c. These waters are concentrated to a specific gravity of 1·15, and, in order to remove the volatile impurities, steam of 198° to 216° F. is used. As soon as this cleansing process is completed, the glycerine is distilled by superheated steam, and this second process of distillation may be repeated according to requirements. The distilling process begins at a temperature of 306° F., and finishes at temperatures varying from 495° to 513° F., when the product of distillation may be concentrated in a suitable apparatus.

At a time when the extraction of glycerine was not generally known, these soapy waters were usually thrown away as useless products, just in the same manner as the soap-boiler of the period, broadly speaking, allows the bottom-waters to run off as waste, which, as we shall show, may be likewise turned to the same good advantage.

Glycerine, as introduced in commercial markets, has generally the transparency of water, which is obtained by filtration through animal charcoal, or some such treatment. It is never met with in commercial markets entirely free of water, for practical tests have proved that glycerine of a specific gravity of

1·24	contained	6	per cent.	of water,
1·26	,,	2	,,	,,
1·20	,,	10	,,	,,

Other experiments have shown that glycerine at

30°	B. had a specific	gravity	of 1·250
28°	,,	,,	1·230
26°	,,	,,	1·210
24°	,,	,,	1·190,

the last mentioned being that mostly retailed in commerce, although it need not be inferred from this that glycerine is delivered in this diluted state from the works themselves. It is generally sold according to weight and degrees, the degrees being determined by the Baumé areometer.

Referring to the properties of glycerine, we find it soluble under all conditions in water and spirits of wine, but not so in ether; when mixed with water and barm, it will not ferment. It dissolves all liquid salts, vegetable acids, sulphate of potash, natron, baryta, strontium, iodine, &c. Strong sulphuric acid combines with glycerine, under heat manifestations, producing sulphuric acid, and glycerin sulphuric acid. Glycerine may be decomposed by chloride and bromine, forming in the first instance chlorhydric acid and an oily acid (chlo-glycerin), and in the latter case hydrobromic acid and bromide glycerine. A further property of glycerine is that the greatest summer heat will not cause it to evaporate, nor will it become solid with extreme cold. Under these circumstances it always retains its original form, a thick liquid. Its exceedingly harmless properties render it suitable to many purposes, which are daily increasing.

All these forementioned properties render glycerine exceedingly useful both in the industries and the household. A little glycerine added to wine will stop its fermentation. Decomposition is prevented by the use of glycerine, for it neither ferments nor decomposes,—a fact in itself which is well worth attending to both in the kitchen and the cellar.

Another industrial application of glycerine, which allows its use in quite another direction, is that it does not freeze, or at all events very seldom. The glycerine we buy is certainly always mixed with water, and when it contains, for instance, 60 per cent. of water, it will freeze at 31½° F.; the less water it contains, the lower will its freezing point be. This is a much-desired property for all technical purposes where a liquid is required to be capable of resisting effects of cold. Amongst the various uses to which glycerine is applied in this respect we will simply enumerate gas-meters. In these instruments one should be able to read off the quantity of gas consumed both in summer and winter; therefore, in all such instruments where a fluid is used as a regulating body exposed to all the influences of the weather, pure glycerine will prove itself a perfect boon.

This non-freezing property might lead us to suppose that glycerine on this account renounced all the characteristics of fatty matters. But in reality it is otherwise, for it finds a far more practical value in the trades than the application of oils, &c., as lubricators suggest. Its excellent property of combining readily with every other liquid without diluting itself, and its non-evaporating nature, fulfil the most sanguine expectations that can be expected of a really practical liquid.

In wool-spinning and turkey-red dyeing, where hitherto olive oil was used, and could only be removed by several re-washings owing to the nature and the disagreeable smell of the oil, glycerine is now mostly used, and requires simple washing and rinsing.

Mechanics, watchmakers, and others find in this never varying substance a capital lubricating material for their coarse and delicate implements. Solutions of gum would not be apt to decompose, if mixed up with glycerine, instead of water, as is usually done.

The use of glycerine likewise recommends itself for household purposes. So, for instance, ripe fruit can be kept in it for years, and retain its original freshness as if it had just been taken off the tree. Meat and eggs can be readily retained sweet by glycerine, and, if the sweet taste is not palatable, it can be readily removed by washing it off. If provision dealers, hotel keepers, and dining-room proprietors, or cooks in general, instead of placing their meat in badly constructed ice-safes in hot weather, would but place it in glycerine, we should not hear so much of diseased meat, nor should we so often be disappointed at finding our food tainted in hot, sultry weather. If butchers would but accept this property that glycerine possesses, they might be able to command constant prices all the year round both of the meat consumer and of the soap-boiler for their tallow (fat).

Snuff and tobacco, which dry quickly even in hermetically sealed zinc boxes, only require to be slightly damped with diluted glycerine, to retain their original humidity, and this is a fact which has already been made use of by tobacco manufacturers. The photographer, to whom the rapid drying up of his collodion is a constant source of annoyance, causing the thin collodion-layer on the plate to shrivel up and crack, may remove this difficulty by the slight addition of glycerine, and so render the collodion even and elastic. The sculptor's modelling earth may by the same addition be rendered fit for use even after days of interrupted labour. Copying ink may be so prepared, inasmuch as the glycerine will keep what is therewith written constantly moist, so enabling copies to be taken from it.

In addition to the forementioned applications, glycerine finds a practical application in pharmacy, in the preparing of printers' rollers, in the manufacture of dynamite, in the brewing of beer, in the distilling of "liqueurs," in dyeing processes, &c.

In fact, if we look at the various industries, we shall find few who would not counsel the use of glycerine, and many of these industries have attained a perfection through its application which even in the most sanguine minds was never thought of.

Let us, for instance, gaze at the perfumery trades, and the manufacture of toilet soap, and we shall find that they owe their fragrance and attractions to the use of glycerine. The delicate flower odours which form the most subtile of essential oils, and which are already disturbed by the most careful distillation, are now extracted with a beautiful cleanliness by the use of glycerine. Hence we have the sweet-smelling pomades and hair oils, and all those other flower essences of our modern perfumery works. It would appear that glycerine possesses such undisputed authority over all the subtile volatile essential odours, that by merely placing it in contact with the latter they are brought to an entire subjugation, and we in our turn have merely to separate the one from the other to obtain the perfume in the purest quality.

If these propensities may be said to be only applicable to the luxuries of the age, it may be easily shown that glycerine is a friend in deed to the human body in need.

Although the statement made some time ago is exaggerated, that glycerine was a sure cure to deafness, still it may certainly be used in the ear, and be a means of softening any hard matter which may have accumulated therein. In modern practice it is prescribed by doctors for curing coughs and catarrh. In cases of skin-burns it will prevent the skin from blistering and mattering if a few drops are applied to the portion hurt. Human skin is apt to dry and chip, but if rubbed with glycerine a softness to the skin is soon imparted. Equally efficacious is glycerine in its property of closing or healing wounds, and under this respect it is best used in the form of glycerine composition, which can be readily made by mixing equal parts of glycerine with corresponding parts of the yolk of eggs. It becomes then a fatty compound, which prevents the access of air to the wound, keeping itself fresh, and so accelerating the healing process. Glycerine possesses in this regard an advantage over the otherwise highly commended collodion, for, ignoring the danger of the latter, it is very difficult to obtain a uniform spreading of collodion owing to its rapid evaporation.

Just in the same manner as we may look upon glycerine as a result of scientific research, so it may be said to return service to science in promoting it. Microscopy, for instance, derives a great benefit from glycerine. It was always a matter of the greatest concern to those engaged in this science, that the preserving of both vegetable and animal humid microscopical objects was attended with so much difficulty and little success. All the means formerly applied for embalming the objects between the glass pieces, such as, for instance, the use of the balsam of the copaiva tree, of alcohol, or of chloride of calcium, proved ineffectual; the objects soon lost their original hue, or were chemically affected, &c. But this anxiety need no longer exist, for, if these objects be covered with a tincture of glycerine, their original form and colour will be easily retained.

Yet this article—glycerine—conferring, so to speak, so many blessings to our mortal requirements, may be traced back to despicable fatty matter, for, as has already been stated, it appears as a secondary product in the manufacture of stearine candles, and may also be found in the works of the soap-boiler or in the establishments of soap-manufacturers, where tallow or other fats are mixed with alkalies for soap purposes and subsequently separated with salt.

Tallow is to glycerine just what coal-tar is to benzine or to the magnificent aniline colours. Tallow is not a simple body, but compounded in many respects, and, if science has only now succeeded after long and dreary investigations in proving this last assertion, we may the more be amazed at the wisdom of nature in preserving this secret for the enlightened period of the age. Amongst all the *savans* of past generations, which of them would have thought that tallow was anything else than tallow? Melted or treated with water it still remained the same, and if mixed with alkalies became at the utmost soapy. Yet now we know that tallow is composed of many different matters which are concealed in it, as all the superb rainbow colours are concealed in the simple white sunbeam!

To prove this, we may refer the reader to a fact, which he himself may have already ascertained, inasmuch as it refers to a recent period, in which the dull winter lamp was fed by oil. If the frost was keen enough to penetrate to the oil, the latter was certainly not frozen up, but divided in two strange halves, the lower one presenting an oily, thin fluid, the upper one being a solid, tallowy mass. In short, the oil became decomposed in its two chief components, in the thick stearine and the thin oleine. On the other hand, all kinds of oil, fat tallow, palm or olive oils, or other such substances, are easily chemically converted into the same component parts—stearine and oleine—without the use of low temperatures. But these components are not found in equal proportions in all fatty matters; thus, the softer and more liquid an oil or fatty matter is, the more oleine will be formed, and, *vice versâ*, the preponderance of stearine, such as in tallow, will indicate its hardness. Much as the solid portion in tallow is taken up by the stearine, yet, in other fats, the stearine is replaced by other substances, such, for instance, in palm oil by palmitine.

As was stated at the commencement, the bottom-waters of the soap-boiler or soap-manufacturer contain glycerine, yet for centuries past, or since soap was discovered, these waters, otherwise useless, have been thrown away; in fact, this present remark is even applicable at the present day. We cannot, therefore, too strongly recommend the soap-boiler to give his most careful consideration to this valuable product. In short, we do not hesitate in saying that, by following out the practical notes above given, all those classes we have referred to will find these to their own advantage and economy. That this is specially the case with soap-boilers is evident from the fact that a hundred pounds of tallow contain eight pounds of glycerine. Taking an ordinary soap works to work up 1,000,000 lbs. of tallow annually, this would throw off something like 80,000 lbs. of glycerine, and, supposing the value of glycerine to be thirty shillings per hundred pounds, this quantity, if properly worked up, would represent alone a gain of £1,200 annually, which at the present day is mostly allowed to slip through the soap-boilers' hands. That we are not at all exaggerating in this matter, is confirmed by the soap-boiler, Engelhardt, of Leipzig, to whom we are mostly indebted for the preceding remarks; he states distinctly, that among his own acquaintances in the soap manufacturing line there are some who annually consume 5,000,000 lbs. of tallow,—or five-fold the quantity assumed by us—and yet who have never thought of utilizing these waters by extracting the glycerine contained in them, which may therefore be reckoned as a loss of £6,000 sterling to these parties. The great practical bearing, therefore, of this treatment in the economy of manufactures at once becomes apparent from the foregoing, and we trust the English soap-boiler in special may profit with this experience before him.

THE RAPID CORROSION OF IRON IN RAILWAY BRIDGES.[1]

By Wm. Kent.

IT has frequently been noticed that iron used in railway bridges, which is exposed to the smoke, steam, and heated gases escaping from the passing locomotives, shows a greater tendency to corrode than iron in situations not so exposed. In some cases the iron beams and rods on the upper part of the bridge have been found to be rusted to such a depth that the safety of the bridge is endangered. It is, therefore, important to learn the causes of this rapid corrosion, in order to know what steps must be taken to prevent it.

A few weeks ago some pieces of iron rust, taken from a bridge on the Pennsylvania Railroad, were sent to the laboratory of the Stevens' Institute by Engineer J. M. Wilson, of the Pennsylvania R.R., and the writer made a qualitative chemical examination of them, to learn whether such examination would reveal any of the causes of the rusting.

The rust was in several pieces, or flat plates, some of which were as much as one-eighth of an inch in thickness. Some were quite friable, being easily broken by the fingers, while others required a light tap with a hammer to break them. All of the plates were covered on the outer side with a thick coating of a sooty nature, which was no doubt finely divided carbon deposited from the smoke of the locomotives. In other respects the rust was in no way distinguishable to the eye from iron rust formed in the atmosphere under ordinary circumstances. A portion of the rust was finely powdered, put into a flask, and distilled water, free from ammonia, added. The flask was tightly corked, and exposed to a gentle heat for two weeks. The water was then filtered off and examined, to find whether anything had gone into solution. It had a strongly bituminous odour, a thin oily film appeared upon the surface, and it was neutral to test paper. A careful qualitative analysis showed the presence, in the water solution, of iron, ammonia, sulphuric acid, and traces of sulphurous acid and chlorine. Nitric and nitrous acids were searched for, but could not be found. A separate portion of the rust was tested for carbonic acid, and it was found in considerable quantity. The water solution was evaporated to dryness, and a small greyish residue was left.

The result of the analysis suggests at once the causes of the

[1] A Paper presented, by request, to the U.S. Board appointed to examine Iron, Steel, etc., and reprinted from the Journal of the Franklin Institute.

rapid oxidation of the iron. The presence of carbonic, sulphuric, and sulphurous acids, no matter how small in quantity, is sufficient to promote rapid corrosion. The sources from which these substances are derived is evidently the escaping gases of the locomotive, which contain carbonic acid, carbonic oxide, moisture, and, if there is sulphur in the coal, sulphurous and sulphuric acids. The chlorine and ammonia found may come either from the atmosphere, or from the water used in the locomotive. It would be interesting to know the action of each of the various gases above mentioned upon iron, to learn which of them has the greatest tendency to cause corrosion. The literature upon the subject is not extensive. One writer, however, Prof. F. Crace Calvert, has conclusively shown that carbonic acid is a most active agent, in the presence of moisture, to promote corrosion. I refer to papers describing his experiments, published in the London "Chemical News," January 28th and March 11th, 1870, and March 3rd, 1871, and also to his experiments upon the action of sea water upon iron, published in the "Engineer," August 25th, 1865, and "Engineering," December 20th, 1867.

Among other interesting observations Prof. Calvert remarks that Claude Berdoulin first observed, in 1683, that ammonia is formed when aërated water acts upon steel. In 1720, E. F. Geoffroy found that iron rust formed in the air contains moisture and ammonia. In his paper of March 3rd, 1871, Prof. Calvert states that iron rust is generally supposed to be a hydrated sesquioxide of iron, containing a trace of ammonia, but two analyses made by him show that its constitution is much more complicated.

The following are the two analyses mentioned. The specimens were formed in the atmosphere, where they were carefully protected from any source of contamination :

	Rust from Conway Bridge.	Llangollen.
Ferric Oxide	93·094	92·900
Ferrous Oxide	5·810	6·177
Carbonate of Iron . . .	0·900	0·617
Silica	0·196	0·121
Ammonia	traces.	traces.
Carbonate of Lime . . .		0·295

Prof. Calvert asks the question: "Is the oxidation of iron due to the direct action of the oxygen of the atmosphere, or to the decomposition of its aqueous vapour, or does the very small quantity of carbonic acid which it contains determine or intensify the oxidation of metallic iron?" To reply to it, he made a long series of experiments, by exposing perfectly cleaned blades of steel and iron to the action of different gases. After a period of four months, the blades showed the following results :

Dry oxygen—No oxidation.

Damp oxygen—In three experiments one blade only was slightly oxidized.

Dry carbonic acid—No oxidation.

Damp carbonic acid—Slight appearance of a white precipitate upon the iron, found to be carbonate of iron.

Dry carbonic acid and oxygen—No oxidation.

Damp carbonic acid and oxygen—Oxidation very rapid.

Dry and damp oxygen and ammonia—No oxidation.

These facts tend to show that carbonic acid, and not oxygen nor aqueous vapour, is the agent which determines the oxidation of iron in the atmosphere. Prof. Calvert also made experiments upon iron immersed in water containing carbonic acid, in sea water, and in very dilute solutions of hydrochloric, sulphuric, and acetic acids. In one case a piece of cast iron placed in a dilute acetic acid solution for two years was reduced in weight from 15·324 grams to 3½ grams, and in specific gravity from 7·858 to 2·731, while the bulk and outward shape remained the same. The iron had gradually been dissolved or extracted from the mass, and in its place remained a carbon compound of less specific weight, and small cohesive force. The original cast iron contained 95 per cent. of iron and 3 per cent. of carbon, the new compound only 80 per cent. of iron and 11 per cent. of carbon. Iron immersed in water containing carbonic acid was also found to oxidize rapidly. Prof. Calvert states that the oxidation in this case was not due to the fixation of the oxygen dissolved in the water, but to oxygen liberated from the water by galvanic action. The occurrence of hydrogen collected above the liquid in the bottles proved this sufficiently.

When distilled water was deprived of its gases by boiling, and a bright blade introduced, it became in the course of a few days here and there covered with rust. The spots where the oxidation had taken place were found to be impurities in the iron, which had induced a galvanic action, just as a mere trace of zinc placed on one end of the blade would establish a voltaic current.

With these researches of Prof. Calvert before us we have no difficulty in accounting for the rapid oxidation of iron in railway bridges. All the conditions necessary to promote corrosion are present. The carbonic acid and moisture escaping from the locomotives would themselves be sufficient; but when to this we add the sulphuric acid and chlorine, both of which were found in the analysis, we have, when they are dissolved in the moisture, an acid or a saline liquid capable of the most energetic action. Furthermore, the presence of the carbonaceous deposit has no doubt a tendency to assist the corrosion, both by its acting as a nucleus which retains the moisture and acid, and condenses the gases within its pores, and by its inducing galvanic action, carbon being electro-negative to iron. The reason of the presence of ammonia in iron rust is stated by Bloxam, who says that it is formed from the nitrogen in the air during the process of rusting. It appears that the water is decomposed by the iron, and the liberated hydrogen enters at once into combination with the nitrogen held in solution by the water to form ammonia.

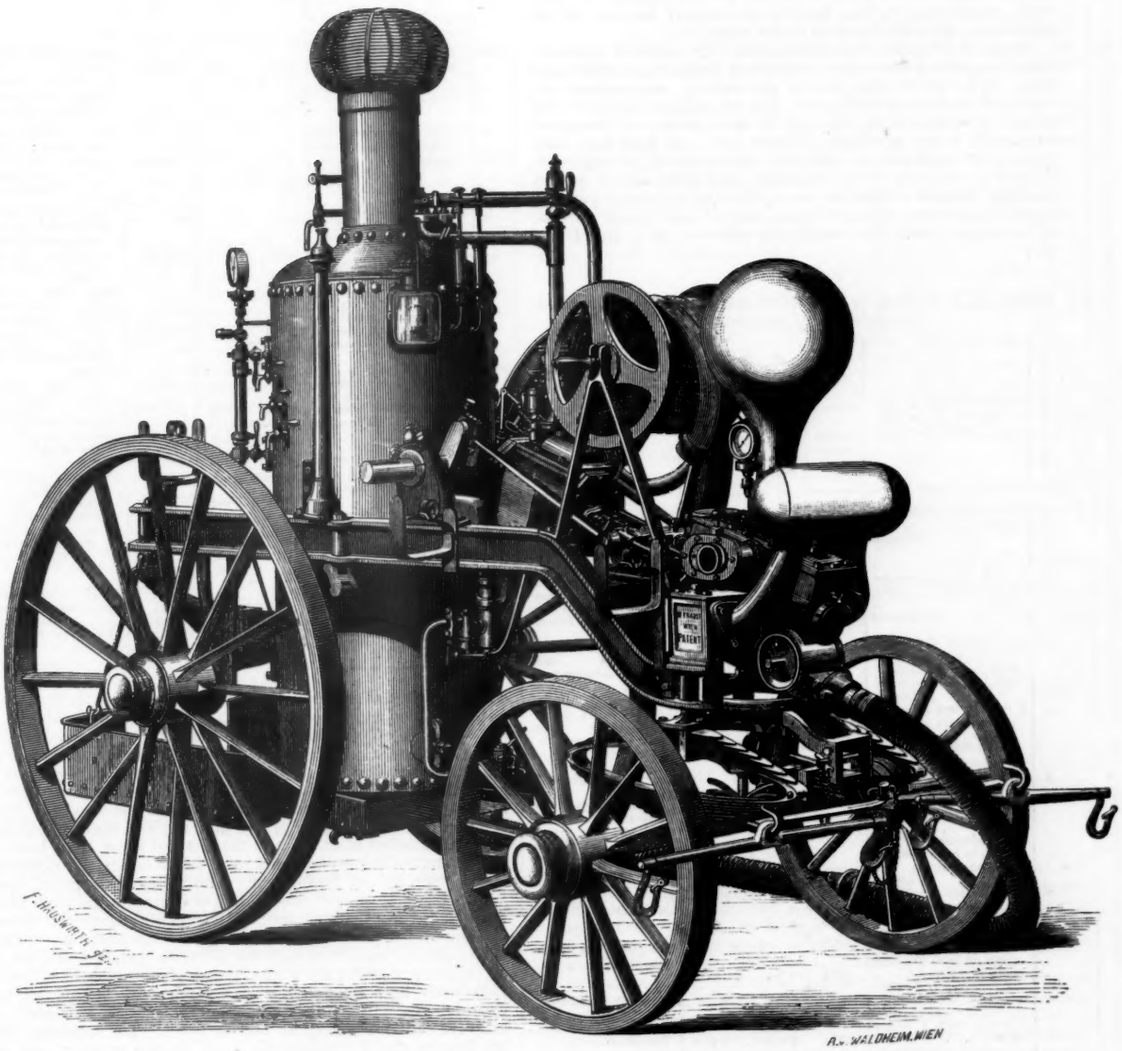
In connection with this subject, the writer has made an experiment to determine the action of sulphurous acid upon iron, as follows : Two one-half litre flasks were taken, and in one were placed about two ounces of clean and bright wrought iron turnings, and in the other two ounces of old rusty lath nails. Ten cubic centimetres of water were added to each, enough to merely wet the iron, and a current of sulphurous acid gas was then passed into each for a few minutes, and the flasks tightly corked and sealed. The gas had an immediate and energetic action in each case. The bright turnings at once became black, and then a white sandy-like deposit appeared in the bottom of the flask. On shaking this deposit around the side of the flask, it in a few minutes changed to a greyish colour, and afterwards a part of it became of the colour of iron rust. The lath nails in the other flask at first lost their rusty appearance, and then the white deposit appeared as in the first case. A third flask was then taken, and ten cubic centimetres of water put in it and filled with sulphurous acid gas and corked, but no iron was put in it. All three flasks were kept corked for a week, and then opened. The third flask had a suffocating odour of sulphurous acid, and the water in the bottom contained both sulphurous and sulphuric acids. The other flasks were entirely free from any smell of sulphurous acid. The water was tested and found to contain protosulphate of iron. The precipitate around the sides of the flask was dissolved in hydrochloric acid and found to contain sulphuric acid and iron, both as ferrous and ferric oxides. The iron nails and turnings were weighed and found to have lost nearly 1 per cent. of their original weight. This experiment seems to show that sulphurous acid is rapidly changed into sulphuric acid in the presence of iron and moisture, and that the iron is thereby rapidly corroded. The sulphurous acid escaping from the locomotives must, therefore, be considered one of the most active agents of the corrosion of railway bridges.

LOCOMOTIVE STEAM PUMP AND FIRE-ENGINE.

WE reproduce from "Stummer's Ingénieur" the annexed representation of a locomotive steam pump and fire-engine, constructed at the Locomotive and Fire-engine Works of M. Knaust, at Vienna. The machine, which is described as remarkably light and well built, runs upon four wheels, and is adapted for pair-horse draught. It can be used either as an ordinary locomotive to supply the motive power for driving farm and other machinery, or as a steam pump, or, in case of need, as a steam fire-engine. It is made in two sizes—the smaller of 5-horse power, and the larger of 10-horse power.

When acting as a pump or fire-engine, the smaller size will raise 27,000 litres (6,000 gallons), and the larger 54,000 litres (12,000 gallons) in the hour. Some of the principal dimensions and the weight of each are shown below :—

	5-Horse Power.	10-Horse Power.
Diameter of upright boiler . . .	600 millimetres	850 millimetres.
Height of ditto .	1,600 „	2,000 „
Heating surface .	5 square metres	9·5 square metres
Diameter of steam cylinder . .	120 millimetres	165 millimetres.
Ditto piston-head of pump . .	90 „	125 „
Length of stroke .	200 „	250 „
Number of revolutions per minute .	180 „	150 „
Steam pressure in boiler . .	8 atmospheres	ditto „
Weight of locomotive, with hose complete . .	1,485 kilogs.	1,950 kilogs.



LOCOMOTIVE STEAM PUMP AND FIRE-ENGINE.

ACTION OF CERTAIN SOLUTIONS ON IRON.

PROFESSOR WAGNER, of Munich, describes a series of experiments instituted to determine the action on iron plates of various substances in common use as scale-preventatives. Amongst the chemical methods employed for the prevention of scale in boilers are the addition of lime, soda, sal-ammoniac, &c., besides preliminary heating of the feed-water, the addition of oil to the water, &c.

Professor Wagner's first experiments were designed to ascertain the extent of the action upon iron of these several substances when in a soluble state, in the presence of atmospheric air, with and without carbonic acid, and at ordinary temperatures. Strips of iron cut from one and the same plate were immersed separately in the specified solutions after the bath had been thoroughly impregnated with air by means of an aspirator. They were weighed before immersion, and at the end of a week carefully washed in distilled water, dried on blotting-paper, and again weighed, the solution being filtered and tested for iron at the same time. The results are observed in Tables I. and II.:—

I.

Rusting of Iron Plate in a Solution saturated with atmospheric Air deprived of carbonic Acid.

No. of experiment.	Volume of each solution 75 cubic centm. (4½ cubic in.)	Weight of Iron Plate in Grammes. Before immersion.	Weight of Iron Plate in Grammes. After 1 week's immersion.	Loss of weight per cent. in Iron Plate after one week's immersion.	Remarks.
1	Fresh unboiled distilled water . . . . . Difference	3·004	2·979 0·025	0·83 p. c.	Reddish-yellow ferruginous precipitate; iron quite black; filtered solution free of iron.
2	1 litre of spring water boiled down to 75 cubic centm. . . . . Difference	3·245	3·204 0·041	1·26 p. c.	Large reddish-yellow precipitate; iron somewhat rusted; filtered solution free of iron.
3	½ gr. chloride of barium, and ½ gr. chloride of lime dissolved in fresh unboiled distilled water Difference	3·402	3·346 0·056	1·63 p. c.	Large yellowish-red precipitate; iron rusted; solution free of iron.
4	½ gr. common salt, and ½ gr. chloride of potash dissolved in fresh unboiled distilled water . Difference	3·083	3·046 0·037	1·20 p. c.	Large yellowish-red precipitate; iron rusted; filtered solution free of iron.
5	½ gr. chloride magnesia dissolved in fresh unboiled distilled water . Difference	3·000	2·958 0·042	1·40 p. c.	Large yellowish-red precipitate; iron rusted; filtered solution showing traces of iron.
6	½ gr. sal-ammoniac dissolved in fresh unboiled distilled water . . . Difference	3·254	3·212 0·042	1·09 p. c.	Large yellowish-red precipitate; iron rusted; solution free of iron.
7	½ gr. hydrate of calcium in fresh unboiled distilled water . . . . Difference	2·876	2·876 0	0	No precipitate; iron unaffected.
8	½ gr. carbonate of soda dissolved in fresh unboiled distilled water. . . . Difference	2·664	2·664 0	0	No precipitate; iron unaffected.
9	1 litre of spring water boiled down to 75 cubic centm., with 5 drops of oil . . . . . Difference	3·154	3·139 0·015	0·47 p. c.	A small yellowish-red precipitate; iron pretty clean; solution free of iron.

In these experiments, it will be seen, iron rusted twice as much in unboiled distilled water, containing atmospheric air and carbonic acid, as in distilled water containing atmospheric air only. On the other hand, in boiled spring water, there was less rust in the presence of atmospheric air and carbonic acid than when atmospheric air alone was present. In both cases, oil appeared to protect the iron; and the addition of soda or potash prevented oxidation altogether.

Another experiment was made in which a similar piece of iron was laid for a week in distilled water saturated with well-washed carbonic acid only. The iron weighed 3·248 gr. before immersion, and 3·236 gr. after, showing a loss of weight of 0·012 gr., or 0·37 per cent. There was a reddish-yellow precipitate; the iron was free of rust; but the filtered water showed traces of iron, proving the truth of the belief that iron oxidizes in water containing carbonic acid without the presence of oxygen.

II.

Rusting of Iron Plate in a Solution saturated with atmospheric Air and carbonic Acid.

No. of experiments.	Volume of each solution 75 cubic centm. (4½ cubic in.)	Weight of Iron Plate in Grammes. Before immersion.	Weight of Iron Plate in Grammes. After 1 week's immersion.	Loss of weight per cent. in Iron Plate after one week's immersion.	Remarks.
1	Fresh unboiled distilled water . . . . . Difference	3·268	3·218 0·050	1·53 p. c.	Large reddish-yellow precipitate; iron somewhat rusted; filtered solution containing a large proportion of iron.
2	1 litre of spring water boiled down to 75 cubic centm. . . . . Difference	3·039	3·008 0·031	1·02 p. c.	Some reddish-yellow precipitate; iron rusting; filtered solution containing large proportion of iron.
3	½ gr. chloride of barium, and ½ gr. chloride of lime dissolved in fresh unboiled distilled water Difference	2·868	2·826 0·042	1·46 p. c.	Large reddish-yellow precipitate; iron very much rusted; filtered precipitate containing large proportion of iron.
4	½ gr. common salt, and ½ gr. chloride of potash dissolved in fresh unboiled distilled water . Difference	3·099	3·036 0·063	2·03 p. c.	Very large reddish-yellow precipitate; iron completely rusted; filtered precipitate containing very large proportion of iron.
5	½ gr. chloride of magnesia dissolved in fresh unboiled distilled water . Difference	3·245	3·185 0·060	1·85 p. c.	Very large reddish-yellow precipitate; iron completely rusted; filtered solution containing very large proportion of iron.
6	½ gr. sal-ammoniac dissolved in fresh unboiled distilled water . . . Difference	3·094	3·027 0·067	2·16 p. c.	Very large yellowish-red precipitate; iron completely rusted; filtered solution containing very large proportion of iron.
7	Experiments not completed	—	—	—	—
8	Do.	—	—	—	—
9	1 litre spring water with 5 drops of oil boiled down to 75 cubic centm. Difference	3·126	3·103 0·023	0·73 p. c.	Small reddish-yellow precipitate; iron clean; filtered solution shows few traces of iron.

The belief that saline solutions absorb air less rapidly than pure water was also shown to be open to exception. Equal volumes of the solutions of common salt and chlorate of potash and sal-ammoniac and of distilled water were saturated simultaneously, for the space of three days, with atmospheric air deprived of carbonic acid, and were afterwards placed under the receiver of an air-pump, and the air in them exhausted and weighed. The solution of common salt and potash in distilled water was found to have absorbed most air, and the distilled water alone least.

The succeeding experiments were to ascertain the corrosive effects upon iron of the foregoing solutions under long-continued heat. For this purpose small strips of iron from the same plate were placed in separate glasses of 200 cubic centimetres (about one-third of a pint) capacity, provided with porcelain covers. These glasses were filled with the solutions specified, and put in an ordinary room for six weeks upon a porcelain stove, where a sufficiently high temperature was maintained throughout the day (the experiments were made in January and February), to keep the contents nearly at boiling point. The solutions were left free to absorb atmospheric air on cooling at night, and the glasses, with the exception of that used in experiment No. 12, were kept filled up with distilled water as required. This iron was weighed before immersion, and at the end of each week, and the filtered solution tested for iron as before. The results may be gathered from Table III.

Summarizing the results of his experiments, Professor Wagner remarks "that they demonstrate the presence of the various chlorides (chloride of magnesia, common salt, sal-ammoniac, chloride of barium, chloride of lime) to be detrimental to iron exposed to atmospheric action, as in steam boilers. It is a question whether the beneficial effects of barium chloride when employed in ridding the feed-water of sulphate of lime must not be more than counterbalanced by its subsequent effects on the boiler plates. When magnesium salts are present in the water, the evil will be aggravated by the formation of chloride of magnesia. Boiled spring water appears to favour oxidation less than pure water, especially when the increase of temperature produces a thin deposit of scale protecting the surface of the iron.

III.

No. of Experiment.	Glass vessels holding each 200 cubic centm. filled with the under-specified solutions.	Weight of Iron Plate in Grammes. Before Immersion.	After 1 week.	After 2 weeks.	After 3 weeks.	After 4 weeks.	After 5 weeks.	After 6 weeks.	Remarks after 6 weeks' immersion.
1	Distilled water . . .	1·827	1·819	1·812	1·806	1·799	1·790	1·782	Reddish-yellow precipitate iron blackened; filtered solution showing traces of iron.
	Difference per week		0·008	0·007	0·006	0·007	0·009	0·008	
2	2 litres spring water boiled down to 200 cubic centm. .	1·848	1·840	1·836	1·835	1·834	1·830	1·825	Reddish-yellow precipitate; white parts of iron turned black; filtered solution free of iron.
	Difference per week		0·008	0·004	0·001	0·001	0·004	0·005	
3	2 litres spring water boiled down, with the addition of 1 gr. barium chloride to 200 cubic centm. . . .	2·594	2·590	2·582	2·576	2·570	2·566	2·562	Thick reddish-yellow precipitate; iron a good deal blackened; filtered solution free of iron.
	Difference per week		0·004	0·008	0·006	0·006	0·004	0·004	
4	1 gr. chloride of barium, and 1 gr. chloride of lime dissolved in distilled water .	2·859	2·840	2·821	2·814	2·807	2·801	2·794	A good deal of reddish yellow precipitate; the iron black: the filtered solution free of iron.
	Difference per week		0·019	0·019	0·007	0·006	0·006	0·007	
5	1 gr. common salt and 1 gr. chloride of potash dissolved in distilled water . .	1·906	1·890	1·878	1·865	1·857	1·848	1·841	Large reddish-yellow precipitate; iron quite black; filtered solution free of iron.
	Difference per week		0·016	0·012	0·013	0·008	0·009	0·007	
6	1·9 gr. chloride of magnesia dissolved in distilled water	3·443	3·398	3·377	3·367	3·357	3·348	3·338	Large reddish-yellow precipitate; iron quite black; solution free of iron.
	Difference per week		0·045	0·021	0·010	0·010	0·009	0·010	
7	2·7 gr. chloride of magnesia, with a sprinkling of finely powdered carbonate of lime dissolved in distilled water	2·596	2·573	2·556	2·542	2·532	2·519	2·511	Large reddish-yellow precipitate; iron a little blackened; solution free of iron.
	Difference per week		0·023	0·017	0·014	0·010	0·013	0·008	
8	1 gr. of sal-ammoniac dissolved in distilled water .	1·991	1·968	1·954	1·940	1·928	1·918	1·908	Large reddish-yellow precipitate; iron completely rusted; solution free of iron.
	Difference per week		0·023	0·014	0·014	0·012	0·010	0·010	
9	1 gr. hydrate of lime in distilled water . . .	1·964	1·964	1·964	1·964	1·964	1·964	1·964	No precipitate; iron quite clean.
	Difference per week		0	0	0	0	0	0	
10	1 gr. carbonate of soda in distilled water . . .	1·968	1·968	1·968	1·968	1·968	1·968	1·968	No precipitate; iron quite clean.
	Difference per week		0	0	0	0	0	0	
11	1 litre of spring water with 10 drops of oil boiled down to 200 cubic centm. . .	1·924	1·913	1·913	1·912	1·910	1·908	1·906	Very small precipitate; iron clean; filtered solution free of iron.
	Difference per week		0·011	0·000	0·001	0·002	0·002	0·002	
12	A glass of 200 cubic centm. capacity kept half full only of distilled water . .	2·469	2·444	2·429	2·403	2·378	2·357	2·341	Thick reddish-yellow precipitate; iron quite black; filtered solution containing iron.
	Difference per week		0·025	0·015	0·026	0·025	0·021	0·016	

Oils and fatty matters would not seem to be in any wise injurious to the iron; but, it must be remembered, the experiments were not tried at temperatures exceeding 100° C. (boiling point of water). Sal-ammoniac appears to be invariably injurious in its effects. Alkaline reagents, such as lime or soda, added to the feed-water in due proportion, neither in defect or excess, would appear to be the best antidotes to scale. *Bayerisches Indust. in Gewerbe-Blatt, April*, 1875.

HOW TO TAKE CARE OF CHINA AND GLASS WARE.

IN the average household few things suffer more from ill usage than porcelain and glass, especially the finer kinds of such ware. We copy from the Boston "Journal of Chemistry" a few practical suggestions on the best methods of cleansing and preserving these fragile materials.

One of the most important things is to season glass and china to sudden change of temperature, so that they will remain sound after exposure to sudden heat and cold. This is best done by placing the articles in cold water, which must gradually be brought to the boiling point, and then allowed to cool very slowly, taking several hours to do it. The commoner the materials, the more care in this respect is required. The very best glass and china is always well seasoned, or annealed, as the manufacturers say, before it is sold. If the wares are properly seasoned in this way, they may be washed in boiling water without fear of fracture, except in frosty weather, when, even with the best annealed wares, care must be taken not to place them suddenly in too hot water. All china that has any gilding upon it may on no account be rubbed with a cloth of any kind, but merely rinsed first in hot and afterwards in cold water, and then left to drain till dry. If the gilding is very dull and requires polishing, it may now and then be rubbed with a soft wash-leather and a little dry whiting; but this operation must not be repeated more than once a year, otherwise the gold will most certainly be rubbed off and the china spoilt. When the plates, &c., are put away in the china closet, pieces of paper should be placed between them to prevent scratches on the glaze or painting, as the bottom of all ware has little particles of sand adhering to it, picked up from the oven wherein it was glazed. The china closet should be in a dry situation, as a damp closet will soon tarnish the gilding of the best crockery.

In a common dinner service, it is a great evil to make the plates too hot, as it invariably cracks the glaze on the surface, if not the plate itself. We all know the result—it comes apart; "nobody broke it," "it was cracked before," or "cracked a long time ago." The fact is, when the glaze is injured, every time the "things" are washed the water gets to the interior, swells the porous clay, and makes the whole fabric rotten. In this condition they will also absorb grease, and, when exposed to further

heat the grease makes the dishes brown and discoloured. If an old, ill-used dish be made very hot indeed, a teaspoonful of fat will be seen to exude from the minute fissures upon its surface. These latter remarks apply more particularly to common wares.

As a rule, warm water and a soft cloth are all that is required to keep glass in good condition; but water-bottles and wine decanters, in order to keep them bright, must be rinsed out with a little muriatic acid, which is the best substance for removing the "fur" which collects in them. This acid is far better than ashes, sand, or shot; for the ashes and sand scratch the glass, and if any shot is left in by accident the lead is poisonous.

Richly cut glass must be cleaned and polished with a soft brush, upon which a very little fine chalk or whiting is put; by this means the lustre and brilliancy are preserved.

HORIZONTAL EXPANSION ENGINE.

OBSERVING that, in practice, the working of steam-engines on the principle of variable expansion has hitherto been greatly restricted in its application by the complexity of the mechanical arrangements involved, even in those engines which best fulfil the object sought, "Stummer's Ingénieur" (11th June, 1875) directs especial attention to a horizontal engine, constructed at Wannieck's Engine Works, Brünn, on a principle lately patented by MM. Wannieck and Köppner. The annexed plate (fig. 1) gives a front view of this engine; fig. 2, a back view of the same, showing the working of the regulator. The advantages claimed for this engine are directness of action in the regulator, combined with extreme simplicity in all details. The full benefit of the expansion principle is thus attained without the increased outlay, in regard both of prime cost and repairs, necessitated by greater complexity of design; whilst the mode of working is within the comprehension of the humblest ordinary engine-tenter or stoker. The principle is applicable to old engines as well as to new ones. Fuller details, with additional figures and an indicator-diagram, will be found in the above-mentioned journal.

Chemistry applied to the Arts, Manufactures, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

§ 1. *Acids, Alkalies, and Salts.*

DISSOCIATION of Sulpho-Carbonate of Potash in the Presence of Ammoniacal Salts.—M. ROMMIER finds that a mixture of hydrochlorate of ammonia and distilled water with the sulpho-carbonate of potash produces a considerable precipitate of sulphuret of carbon within twelve hours. The sulphate and nitrate of ammonia produce like results. Hydro-sulphate of ammonia gives a small precipitate only; and caustic soda and distilled water have no sensible effect. The practical deduction from this is that the sulpho-carbonate of potash, so strongly recommended as an insecticide for vines and other plants, should not be used in combination with other matters, without a preliminary trial, by direct experiment, of the results of such commixture. *Comptes Rendus, lxxx.* 22, *7th June*, 1875.

§ 2. *Metallurgy.*

Minerals and Timber in Tunis.—Lead mines have been opened by the Tunisian Government at Gieba and Gielagela, but the yield, which is small, has not found its way into the market, owing, probably, to the demands of the Bey's arsenal. Iron ores occur in various localities, particularly at Gierad. Giebel Zerizza, Merigie, and amongst the mountains on the frontier of Algiers. Sea salt is found in abundance, forming *sebke* or salines. Of rock salt there is an unimportant deposit at Giebel Hadifa. The most important mineral deposit in the Regency consists of masses of crystal. It is worked in various places, particularly at Zeremdina, in the district of Susa. In Gierid, provisions are stored in large caves of stalactite. Carbonate of lime occurs in many places; also potters' earth, the most esteemed being that of Nebel. Numerous saline plants furnish large quantities of soda, especially on the plains of Kaironan. Various resinous trees supply tar, chiefly in the mountains of Ouled Ayar and the plain of Kessira. The woods themselves would be valuable, if more judiciously worked. The magnificent forest of Tabarca offers vast supplies of ship timber. Lastly, there are the gum-bushes of Ihala, which, in the opinion of the Marseilles dealers, yield a gum equal to that of Senegal. Besides the mineral deposits previously referred to, the Regency contains numerous beds of limestone and marble, and an abundance of crystallized sulphate of soda, beds of talc and asbestos, agates, carnelians, &c. *L'Economista* (*Florence*), *18th July*, 1875.

"Metalline."—A sample of this composition gave the following analysis:—Lead, 32·40; zinc, 20·07; carbon, 18·89; silica, 6·44; paraffine, 3·98; lime, 3·96; oxide of iron, 3·94; copper, 2·75; magnesia, 1·99; tin, 1·55. When dry, the compound has the appearance of graphite, and is a little harder than lead. It does not fuse with heat, but gives out a tarry odour. Cooling restores it to its original consistency. With the microscope, some of the constituents may be detected, such as small fragments of graphite, metallic particles, and small whitish amorphous granules. *Revue Indust., 4th August*, 1875, *from Dingler's Polytech. Journal.*

§ 3. *Dyeing, Calico Printing, Bleaching, Tanning, and Allied Subjects.*

Aniline Colours without Arsenic.—At the new works of the Aniline-Dye Manufacturing Company, at Tournay, a process of fabricating aniline colours without the aid of arsenic has been introduced. The process has undergone sundry modifications, and the colours now obtained by it are stated to be remarkably pure. Of course they are available for various purposes, for which, whether used or not, the colours prepared with arsenic are wholly unfitted. *Les Mondes*, *5th August*, 1875.

Method of Distinguishing Madder from Artificial Alizarine on Cotton Goods.—After plunging in permanganate of potash, the material to be tested is passed through an acid—madder red turns a yellowish hue; artificial alizarine assumes a decided pink. The distinction is more marked when the material is treated successively with bichromate of potash and nitric acid—madder loses its colour wholly; artificial alizarine retains a characteristic redness. If the material be afterwards worked for some minutes in boiling soda ley of 18° Baumé, then washed and dipped in hydrochloric acid, the madder turns a dirty orange, the alizarine a bright light yellow.

The cheapest and quickest mode of applying the test is as follows:—Prepare a solution of 1 gramme permanganate of potash in 200 cubic centimetres of water; the material is laid therein, washed, passed through hydrochloric acid of 3° Baumé, washed, passed through the permanganate solution again, re-washed, and dipped in a solution of oxalic acid of 1° Baumé. If bichromate of potash is preferred, the material is left for two or three minutes in a bath of 10 grammes bichromate dissolved in 200 grammes of water; it is then washed, wrung out, passed through a nitric acid bath of 50° Baumé, and washed again. *Technologiste, July*, 1875, *from Reimann's Farber-Zeitung.*

Preparation of Baryta Green.—M. BÖTTGER proceeds thus:—In a mixture formed by melting together 2 parts of caustic soda and 1 part of chlorate of potash are introduced 2 parts of finely powdered manganic peroxide. The mass is heated to redness, cooled, and treated with cold water. It is then filtered, and decomposed cold with a solution of nitrate of baryta, the filtered liquor taking a magnificent green colour. The manganate of baryta thus separated is of a rich violet. The latter is washed, and ½ to 1 part hydrate of baryta added. It is then heated to a bright red in a copper or brass vessel, being repeatedly stirred the while. On cooling, the product should have a pure green colour. Lastly, it is finely powdered, and washed with water several times, to remove any traces of baryta hydrate. *Technologiste, July*, 1875.

Eosine.—*Resorcine* is obtained by treating assafœtida with caustic soda; resorcine treated with phtalic acid gives *fluoresceine*, and a tetrabromatized compound of fluoresceine and potash constitutes the new dye, *eosine* (C^{40} H^6 B_2^4 K^2 O^{10}), so named, as before observed, from the supposed resemblance of the hues it produces to the glowing tints of the dawn. Eosine is a reddish brown powder with metallic reflections. It is soluble in water, in alcohol, in alkalis, alkaline carbonates, glycerine, and soaps, but not in ether, carbolic acid, aniline,

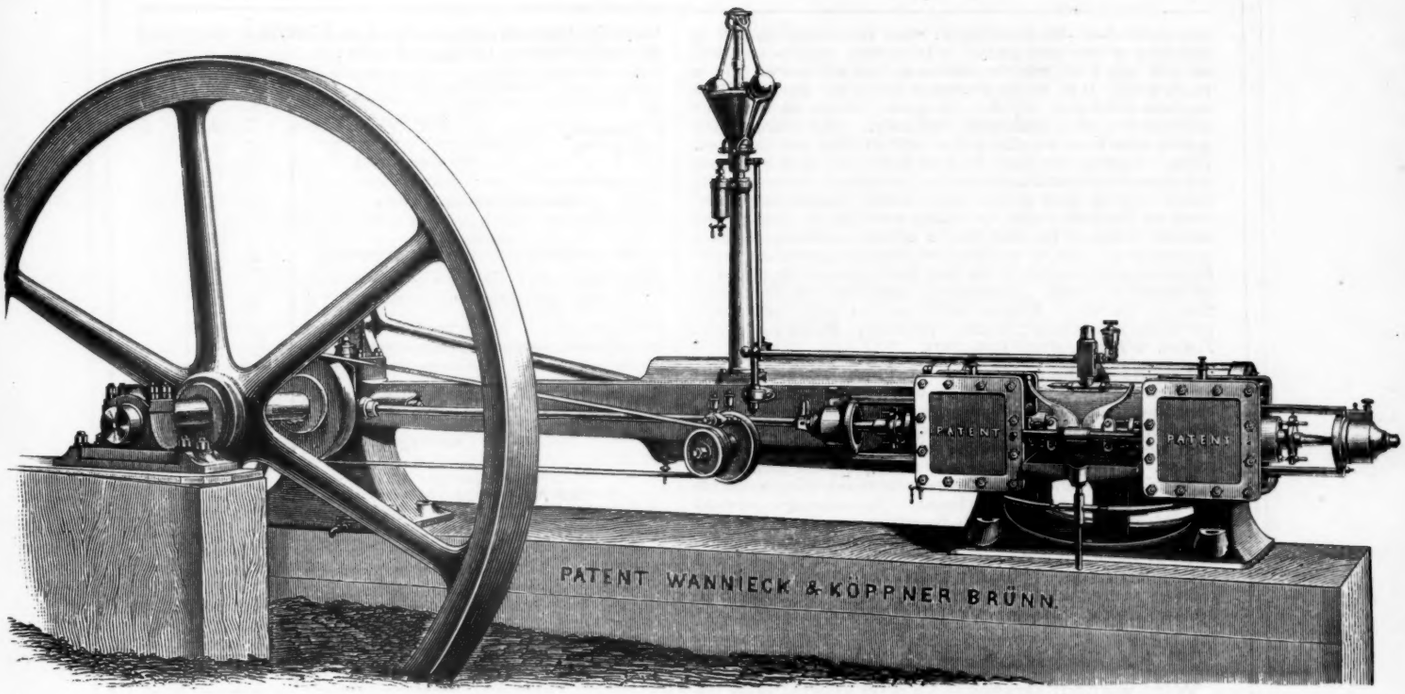


Fig. 1.

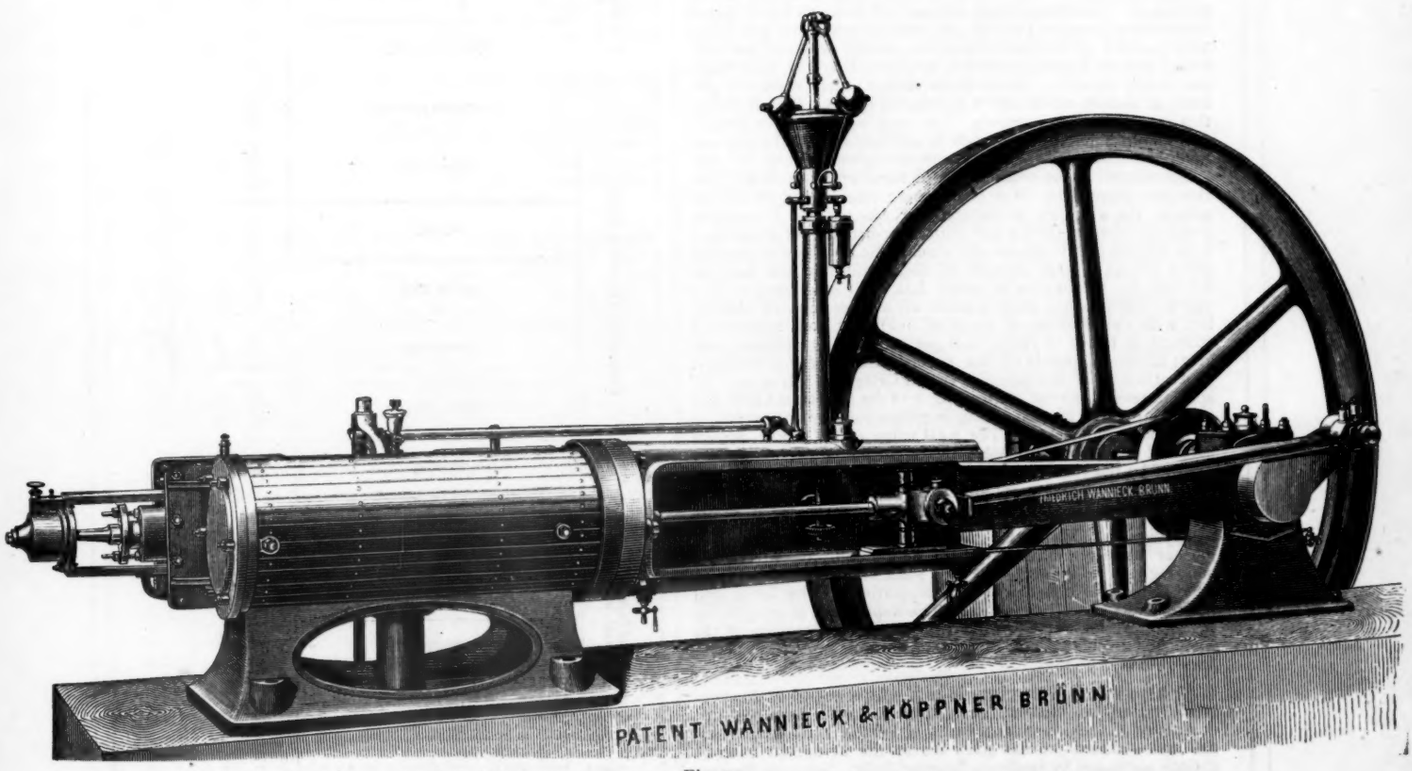


Fig. 2.

HORIZONTAL EXPANSION ENGINE.

oils, or benzine. Its solubility in water is remarkable, and its colouring power very great. It takes very readily and well on silk and wool, and on various animal substances, and is easily fixed. It is merely necessary to lay the material in an aqueous solution of the dye, to quickly obtain an even and uniform tint of considerable brilliancy. The characteristic golden reflections are observable only on silks and in lighter tones. Dyeing cold gives brighter hues than dyeing in heat. All attempts to obtain with this dye, *on cotton*, a colour that will stand soaping, have proved unsuccessful. Eosine may, however, be fixed on cotton by adding arseniate of alumina and acetate of lead or tin after using a suitable mordant, steaming, and washing. But, at the best, *on cotton* it proves eminently fugacious when exposed to the light, and is fittingly described by its name—its hues, comparatively speaking, are fleeting as those of morning. Eosine, which at first cost 1,000 francs per kilog., now sells at 220 francs per kilog. *Bulletin de la Soc. Indust. de Rouen, April-June*, 1875.

Dyeing without Water.—M. PETIT-DIDIER proposes a method of dyeing without water, which appears original in its conception, although no information is given as to its results in practice. He dissolves aniline or other suitable colours in benzine, spirits of wine, turpentine, sulphide of carbon, or similar solvent. It is, of course, necessary to employ with them some appropriate mordant, and for this purpose resins, being amenable to the aforesaid solvents, are chosen. The material to be dyed is dried, and passed between India-rubber rollers overlaid with a mixture of the colour and mordant previously dissolved separately as above. It is then steamed, to fix the colour, dried, and passed through three successive baths of benzine, to dissolve the resinous matter adhering to it. This done, it only remains to dress and fold it. *Moniteur Indust. Belge*, 10*th August*, 1875.

§ 4. *Food, Water, and Sanitary Matters.*

Wine without Grapes.—We never expected to see the manufacture of wine without the juice of the grape defended by any reputable authority; but this seems to have been done at a recent session of the International Viticultural Congress, at Montpelier. On that occasion M. Saint Pierre, a professor in the Medical College of that city, gave some facts in regard to this fabrication of imitated wines, a branch of business which has of late rapidly developed in Hérault, especially at Cette and Mèze. The product of this manufacture is mostly exported, the bulk being sent to Russia, Denmark, Holland, England, and North and South America. Cette alone makes nearly 8,000,000 gallons per annum, worth about 15,000,000 francs. Two-thirds of this is consumed in America. The only wines that can be successfully imitated are those rich in alcohol, such as the wines of Spain and Portugal. It is not true that grape-juice is the only thing omitted in the composition of these wines, as that is the cheapest ingredient. Nor is colouring matter used to any extent, as the wines to be imitated are white. The Portuguese formerly coloured their wines with elder-berries, but abandoned it on finding that it injured the wine. The imitation of Spanish wines utilises a large amount of cheap wines in the south of France, the production of which has been stimulated of late years. These wines show scarcely eleven per cent. of alcohol, but with the addition of syrup of mulberry and alcohol the strength is raised to twenty-one per cent. The professor, with great frankness, pleads for the encouragement of this industry. The members of the congress visited Cette and Mèze, and inspected several manufactories. One of the largest at Cette had then stored over 280,000 gallons in cellars containing from 80,000 to 100,000 gallons each. The total value of the whole deposit is stated at £40,000. At Mèze one establishment astonished the visitors by the vast extent of its coopers' shops, and its steam-engines of great power pumping the wine from great cisterns into the casks.—*Journal of Applied Science.*

Spanish Mineral Waters. — The under-named journal has received an analysis of the mineral water of Couzan, showing it to be impregnated with soda and iron. Mixed with wine it imparts champagne-like properties to the latter and heightens its dietetic properties. The importance of recognizing the commercial value of the various mineral springs of the Peninsula is pointed out. *El Porvenir de la Industria* (*Barcelona*), 16*th July*, 1875.

Analysis of Austrian Beer.—As a sequel to the analytical report on Austrian beers, by Dr. OTTO KOHLRAUSCH, abstracted in the March number of the "Practical Magazine," the under-named journal gives the results of similar investigations instituted by Professor Schwackhöfer. Selecting the two descriptions of beer most drunk in Vienna: 1. "Schwechater Lager," representing the Austrian, and 2. "Pilsner Lager," the Bohemian beers, an analysis of each, as it left the brewery, gave the results shown in the annexed table :—

| Sample Beer. | | |

Adulteration of Oils.—Roth's "Nitro-Sulphuric" Test.— This test, the practical utility of which is highly spoken of by Dr. GOPPELSRŒDER in a report to the Industrial Society of Mulhouse, is prepared as follows :—In a receiver, provided with an escape-pipe and a safety-tube, some fragments of iron weighing about ¼ or ½ lb. each are suspended by wires, and water is poured in until it reaches about 5 millimetres above the orifice of the safety-tube. A small quantity of concentrated nitric acid is then poured through the latter; the nitric acid decomposed by the iron disengages nitric oxide, which passes through a bent pipe into a flask containing sulphuric acid of 46° Baumé. If effervescence ceases, more nitric acid is poured in. The operation should be performed slowly and deliberately, and with large fragments of iron. If the latter be too small, the action becomes unduly energetic. The disengagement of nitric oxide is continued until the sulphuric acid is saturated, which requires six or eight days. The latter, at first colourless, now exhibits a fine greenish blue colour, and constitutes the test spoken of. The mode of operation is to take 9 grammes of the oil to be tested and 7 grammes of the nitro-sulphuric test, beat them together, for the space of a minute, with a glass rod, and leave the mixture to settle. The changes of colour expressed by different oils in the presence of this test constitute one method of distinguishing them, of which an account was given in the "Bulletin" of the Mulhouse Society for March, 1864. The test further allows of the division of oils into siccative and non-siccative oils, and of the classification of the latter according to these degrees of oxidizability or powers of solidifying, which vary with each kind of oil when treated as above described. Various oils, whether pure or in a state of admixture, can thus be distinguished by their behaviour in presence of the test. This furnishes another test-method. Mixtures of 3 per cent. only of oil of sesamum, and of 5 per cent. of various other oils, with olive oil have been detected in this way by M. Roth. *Bulletin de la Soc. Indust. de Mulhouse, April*, 1875.

Formation of Guano.—M. GALACHE suggests that guano may be a geological deposit of the same character as the extensive beds of nitrate of soda and other salts which occur on the coast of Peru. In this case, guano would be an inorganic material containing a fortuitous admixture of organic débris, which latter have become impregnated with the acids and salts of the original deposit. *Comptes Rendus, lxxxi.* 1, *5th July*, 1875.

Action of Ozone on Beet-sugar Juice.—M. MAUMÉNÉ finds that 1 litre of beet-sugar juice will absorb the ozone from several litres of ozonized oxygen (35 to 36 milligrammes per litre) without alteration of the sugar. The odour of the ozone passes off at once; only the colour of the juice disappears. When the odour remains, the sugar is quickly introvented. *Comptes Rendus, lxxxi.* 2, *12th July*, 1875.

Photography as an Aid to Medical Diagnosis.—Dr. UTTZMAN, of the University of Vienna, lately read a paper before the Medical Society of Lower Austria on the use of photography in medical studies. *Inter alia*, he mentioned, on the authority of Dr. Vogel, that an eruption of small-pox had been made evident by photography *twenty-four hours* before it actually came out. Although no one could as yet observe anything on the skin of the patient, the negative plate showed stains that perfectly resembled the variolous exanthem, and twenty-four hours later the eruption became clearly evident. *Lancet*, 31*st July*, 1875.

Action of Plants on Impure Water.—At a recent meeting of the Société Centrale d' Horticulture de France, Dr. JEANNEL related the following experiments with water containing putrid matter :—In the month of May, 60 grammes of water, which had been used for steeping haricots until it had become offensive, and which the microscope showed to be full of *bacteria*, small animalculæ, supposed to be the ordinary agents of putrefaction, was placed in a glass, and the root of a young growing plant plunged therein. An equal quantity of the same water was placed beside it in a test glass at the same time, without a root. The water in the second glass remained infected; that containing the living root, on the contrary, was pure at the end of the fourth day; all the *bacteria* had disappeared, and had been replaced by large infusorial animalculæ of kinds found only in potable water. Water containing putrid meat was treated in the same way with the same results. It was found that it was only necessary to immerse the root of a living plant therein for five days, to remove all the ill odour and render the water pure and sweet. *Revue Indust.*, 21*st July*, 1875.

Beer Test.—To distinguish good, sound, well-seasoned beer, T. J. KRÁL mixes a solution of neutral or basic sulphate of iron of 20° Baumé with a certain quantity of the beer, in the proportion of 1 part of solution to 16 of beer. The latter at once becomes turbid. Old, sound beer, after standing for a quarter or half an hour, precipitates and clears, the portion remaining clouded not exceeding a sixth of the whole volume, whilst the rest becomes pure and bright. Newer beer takes longer, from 12 to 24 hours, to clear, and the turbid portion is larger, amounting perhaps to one half of the volume. In very new beer the deposit is thicker, and after it has subsided the cleared portion is not so bright and pure as in old beer. *Stummer's Ingénieur, 2nd July*, 1875.

Adulteration of Guano.—M. JEAN writes to the French Academy of Sciences :—"A few years ago there began to arrive at Dunkirk large quantities of a yellowish brown material in powder, which is used solely for adulterating guano. Belgian agriculture has suffered most by the fraud, which must be carried on upon a large scale, as over a million kilogs. of the material are brought annually to Dunkirk from England, where it is specially prepared.

"Recently I had the opportunity of analyzing a sample. In respect of colour and weight it closely resembles the guano in actual use; it is inodorous, neutral, nearly tasteless, leaves a colourless ash on calcination, and may be largely mixed with guano without changing the appearance of the latter. Subjected to analysis, it showed thus :—

Water	16·80	
Sulphate of lime	63·50	
Phosphate of lime with traces of oxide of iron and alumina	22·06	
Silica	0·50	
Carb. of lime	1·60	
Chloride of soda	3·71	
Organic matter, dried at 100° C.	1·80	nitrogen 0·3 p.c.
	99·97 (?)	

"The nitrogenized organic matter to which the guano-like colour is due appears to be a material manufactured in England, by treating woollen rags with high-pressure steam.

"The property, possessed by the composition, of leaving a *white* ash on calcination, materially assists the fraud, as it is well known that Belgian buyers are accustomed to calcine, in an iron spoon, small samples of guano offered to them for sale, and to accept those that give a white ash as free from adulteration.

"I have thought it desirable to direct attention to this fraud, which is perpetrated in a very adroit manner, and can only be detected by chemical analysis." *Comptes Rendus, lxxxi.* 4, *26th July*, 1875.

Beer in Tablets or Paste.—TROSTER, represented by Desnos, 17, Boulevard St.-Martin, Paris, patents a method of fabricating beer concentrated in the shape of tablets or paste. For 1,000 litres of Strasburg beer in this form are required 380 to 400 kilogs. of malt or sprouted barley, 7 or 8 kilogs. hops, and about half the ordinary quantity of water. The mixture is placed in a caldron with some fermentable sugar, and boiled down. To prepare it for use, 100 kilogs. of the concentrated product are added to 100 litres of drinking water, and after the lapse of twenty-four hours the ferment is put in. The vessel is filled up with water every twelve hours, and at the end of five days the beer is ready for use. The ferment is kept separately, and added a few days only before the beer is required for use. An addition to the patent provides for the preparation of the beer in capsules or packets, each containing enough for 1 litre of beer. The ferment is prepared in separate packets of proportionate size. *Bull. de la Soc. Chim. de Paris, xxiv.* 2, *5th August*, 1875.

Hygienic Applications of Electricity.—The Abbé MOIGNO directs attention to a system of "Electrical Gymnastics" devised by Dr. Poggioli, and recently tried with marked success, in the presence of a committee appointed by the Prefect of the Seine, upon twenty-one school children expressly selected for their physical weakliness and mental inaptitude. The exact nature of the "gymnastics" is not stated; but the results, we are told, were seen in improved respiration, quickened powers of mental application, improved appetite, and an increase in height and chest-measurement as well as in weight. The beneficial effects remained three months after the conclusion of the course.

Attention is also called to experiments made by Dr. Poggioli, and reported in various French medical journals during the last ten years past, showing that electricity may be usefully employed *as*

a sedative in nervous affections and certain acute forms of disease. *Les Mondes, 5th August*, 1875.

Preserving Provisions in Compressed Air.—Referring to M. Bert's investigations respecting the antiseptic properties of compressed air reported in our last number ("Practical Magazine," August, 1875, p. 246), the Abbé MOIGNO observes that M. Alphonso-Reynoso has anticipated their practical application by his patent process for the conservation of alimentary substances in an atmosphere of high-pressure gas—atmospheric air, oxygen, hydrogen, nitrogen, or ether. Certain of the Paris butchers, it would seem, have been greatly exercised at the prospect of the adoption of this process on an extensive scale. So far, however, from being prejudicial to their interests, the application of the method in suitably constructed rooms would enable them to keep either whole carcases or joints, on their premises, without detriment to the quality of the meat, and without fear of turning, even in the most trying weather. *Les Mondes, 15th July*, 1875.

Powdered Meat.—M. DANNECY, *pharmacien en chef* to the hospitals at Bordeaux, prepares this by finely chopping fresh meat, laying it upon muslin, and drying it in a current of air. A friable mass is formed, which readily yields a brown and nearly odourless powder, possessing a feeble saline taste, and of which 1 part represents 5 parts of fresh raw meat.

From "Les Mondes" of 29th July, 1875, we learn that the preparation is found to mix readily with feculents, cocoa, quinine, phosphate of lime, &c. Mixed with quinine or with pepsine, it is likely to prove of great value in the treatment of disease.

Decortication of Rice.—DON FRANCISCO CABALLERIA Y PAPELL, No. 12, Calle del Albe, Barcelona, has obtained protection (in Spain), for twelve years, for a machine for husking rice. The increasing importance of rice-culture on the banks of the Ebro has rendered a better method of decortication necessary. The machine is not described, but is well spoken of. *El Porvenir de la Industria (Barcelona), 16th July*, 1875.

§ 5. *Fuel, Heating, Illumination, &c.*

Bancoul Nuts.—M. CORRENWINDER gives the annexed particulars respecting the Bancoul or Candle nut and its industrial uses. The nut is the fruit of a species of Euphorbia, of which several varieties exist in the Moluccas, Ceylon, and the Pacific islands. The trees are common also in Cochin China, New Caledonia, Tahiti, and Réunion. The nuts crop largely, and drop off when ripe. They are formed of a hard, ligneous endocarp, with an oily kernel. The latter, in a natural state, contains about 3·625 per cent. of nitrogen. It gives the following analysis:—

Water			5·000
Oil			62·175
Nitrogenous substances			22·653
Non-nitrogenous ditto			6·827
Mineral substances, soluble in water	Potash	0·577	1·078
	Magnesia	0·022	
	Phosphoric acid	0·479	
Ditto insoluble	Magnesia	0·484	2·267
	Lime	0·437	
	Silica	0·155	
	Phosphoric acid	1·191	
			100·00

The nuts experimented upon by M. Correnwinder had been brought home from Tahiti in a French vessel of war, and distributed, by order of the Minister of Marine and the Colonies, amongst various oil-making firms, to test their industrial value. Samples of the oil-cake, left after shelling the nuts and expressing the kernels, were supplied by M. Ed. Nay, of St. Denis, and found to contain 7·65 per cent. of nitrogen. They gave the subjoined analysis:—

Water			10·25
Oil			5·50
Nitrogenous substances			47·81
Non-nitrogenous ditto			24·04
Phosphoric acid		3·68	12·40
Potash		1·53	
Lime		7·19	
			100·00

The cake is, therefore, rich in nitrogen and phosphates, and promises to become a valuable manure. M. Nay obtained about 55 to 57 per cent. of cake, and 40 to 41 per cent. of oil from the kernels. The shelling of the nuts is a most laborious process, owing to the hardness of the endocarp, which is apparently worthless, but forms, on an average, 33 per cent. of the weight of the nut. The oil expressed from the kernels is purgative, and presumably unfitted for alimentary purposes. It burns well—better than colza oil, and needs no purifying beyond simple filtration before use. It has highly siccative properties; and it is authoritatively affirmed that experiments on French vessels of war in Cochin-China and Guiana have demonstrated its value as a preservative of ships' bottoms. *Comptes Rendus, lxxxi.* 1, *July*, 1875.

Cheap Oxygen.—In an interesting "Review of the Progress of the Chemical Arts during the last Ten Years," published in "Les Mondes," Dr. HOFFMANN mentions that the experiments of Kuppelweiser, at Vienna, have shown that oxygen can be manufactured from black oxide of manganese, by the method proposed by Tessié du Motay in 1867, at 3 Austrian florins per 1,000 cubic (Vienna) feet. This agrees closely with the original estimate of the cost, viz., 15 to 30 centimetres per cubic metre. Oxygen of 90 per cent. purity can thus be obtained at a price scarcely exceeding that of ordinary coal-gas. The Abbé MOIGNO, referring to the above, states that the usufruct of the manufactory at Pantin, where the process was first tried, has been secured by M. Patriau, gas contractor, No. 4, Rue des Petits Hôtels, Paris, who has stored considerable quantities of oxygen, at high pressure, in metallic receivers, with a view to its ultimate utilization for industrial and economic purposes. Amongst the latter are mentioned the oxy-hydrogenic lighting of theatres, cafés, &c.; the supply of oxy-hydrogen for metal-workers; of oxygen for a new method of ventilation, of which further details are promised; the preparation of medicinal baths of air and oxygen, under various degrees of pressure, on Dr. Jourdanet's system, &c. *Les Mondes, 15th and 22nd July*, 1875.

Electric Lighting of Workshops.—M. HEILMANN-DUCOMMUN furnishes some particulars of the electric lighting of his foundry. The interior of the building forms a rectangle 220 ft. long by 110 ft. broad. Four electric regulator lamps are placed within it, one at each angle, and at a height of 20 ft. from the floor. Each lamp is provided with a glass globe, and is connected with a separate electro-dynamic machine, on M. Gramme's model. These machines are driven by the steam-engine belonging to the works, an expenditure of about 3 horse-power being required to give a velocity of 1,700 revolutions per minute to the central disc of each of the four machines. The cost of lighting is found to be 0·04 fr. per lamp, per hour of illumination. To this must be added a sum of 1,800 francs per annum, for interest on prime cost of machines and fittings, repairs, allowance for depreciation, and cost of steam power used, which sum must of course be divided by the number of hours of illumination in the year. For a close comparison with the cost of other systems of lighting, photometric experiments would be necessary, which have not yet been made. The light afforded by the four lamps is sufficiently strong to enable small print to be read at an ordinary distance from the eye in any part of the building. *Les Mondes, 5th August*, 1875.

Evils of Illumination with Mineral Oils.—It has been observed in Germany that persons who habitually use petroleum oils for purposes of illumination are subject to an obscure inflammatory affection of the eyes, which often presents catarrhal symptoms. Hitherto this affection has been deemed incurable, as the proximate cause remains unknown, and absolutely pure and innocuous petroleum has not yet found its way into the market. *Technologiste, July*, 1875.

§ 6. *Miscellaneous.*

The Densimeter.—M. PAQUET, Professor of Natural Philosophy at the College of St. Dié, has devised this instrument as a substitute for Nicholson's aerometer, in determining the specific gravity of solids of very small volume. Like Baumé's aerometer, it is in the shape of an elongated pear, carrying an upright stem 15 centimetres in length, with a section of about ¼ square centimetre, surmounted by a tube of larger diameter, closed at the bottom, and divided into cubic centimetres and tenths of the same. The zero is at the second cubic centimetre, and the instrument is weighted so that the bottom of the stem rests on the surface of the water when the superior tube is filled with water up to the zero point, that is to say, when it contains two cubic centimetres of water. The stem is also graduated to another zero. Suppose the instrument

is to serve for the determination of the specific gravities of bodies under six grammes in weight, the upper tube is filled with water to zero, and a weight of six grammes is then placed on it, or six cubic centimetres of water are added. It, of course, sinks, and the new level of the water is marked 60; the space between the 60 and the original zero is then subdivided into 60 parts, each of which will correspond to 1 decigramme. This graduation may be prolonged as far upon the stem as desired.

To use the densimeter proceed as follows:—Pour 2 cubic centimetres of water into the tube at the top of the stem, and plunge the instrument in water. It will float at zero. Place the substance to be weighed in the tube, and it will, of course, raise the level of the water therein, say from 2 centimetres (the zero point) to 3 centimetres. The volume of the substance is then 3 cubic centimetres. The instrument will also be found to have sunk to a certain point on the stem, say, to mark 55. The added weight is, then, 55 decigrammes, or 5·5 grammes. The specific gravity is, of course, $\frac{5{\cdot}5}{3}$.

The densimeter may be employed, like Rousseau's instrument, in determining the specific gravities of liquids. *Bulletin de la Soc. Chim. de Paris, xxiv. 2, 20th July*, 1875.

Tempered Glass.—On 12th ult. the first and at present the only depot for the sale of M. de la Bastie's toughened glass was opened at 38, 40, Chaussée d'Antin, Paris. *Moniteur Scientifique Quesneville, August*, 1875.

The Russian Annual Fair at Nishni-Novgorod.—The "Russische Revue" gives the following particulars of the business transacted at this famous fair during each of the eleven years last past:—

	Value of Merchandize brought to the Fair.	Amount of Sales.
1864 . .	109,000,000 roubles.	92,000,000 roubles.
1865 . .	111,000,000 „	98,000,000 „
1866 . .	125,000,000 „	113,000,000 „
1867 . .	125,000,000 „	104,000,000 „
1868 . .	126,000,000 „	110,000,000 „
1869 . .	144,000,000 „	128,000,000 „
1870 . .	143,000,000 „	125,000,000 „
1871 . .	158,000,000 „	132,000,000 „
1872 . .	177,000,000 „	154,000,000 „
1873 . .	158,000,000 „	138,000,000 „
1874 . .	189,000,000 „	165,000,000 „

Paper-Making in Sweden.—A statistical report of the state of trade and manufactures in Sweden during the year 1873 (the latest), prepared by the Swedish Chamber of Commerce, shows that in that year there were 54 paper-manufacturing establishments in Sweden, giving employment altogether to 2,200 operatives. The following were the quantities and value of the paper manufactured in the aforesaid year:—

	Quantity Reams.	Net. centners	Dec. value. kr.
Imperial, royal, and medium papers	531	27	17,501
Post paper	1,425	97	24,213
Writing and receipt papers . .	28,375	1,576	269,521
Printers' papers	77,827	3,293	914,916
Card and packing papers . .	13,161	16,757	412,381
Marbled and grey papers . .	8,975	2,053	51,357
Other sorts	140,252	146,759	5,153,897
Total	270,545	170,562	6,843,786

The declared value of the above was 1,145,590 kr. in excess of that of the previous year's manufacture, and 2,193,796 kr. in excess of the average annual product of the five-year period, 1868-72. The exports and imports of paper during the year 1873 were as below:—

	Exports.		Imports.	
	Quantity. sk. p.	Declared value. kr.	Quantity. sk. p.	Dec. value. kr.
Packing and roofing paper . .	142,798	15,708	1,306,702	143,737
Cardboard and coloured papers	319,552	95,866	425,396	127,619
Printing and blotting paper.	5,504,050	2,201,620	614,811	245,924
Other sorts of paper. . . .	12,768	8,938	835,616	584,931
Pasteboard . .	9,674	1,064	57,631	6,339
	5,988,842	2,323,196	3,240,156	1,108,550

The above statistics apply to Sweden only, being exclusive of Norway. *Teknisk Tidskrift (Stockholm), May*, 1875.

Hardening of Glass and China.—Amongst recent French patents appear the following:—

HEINSON-HUCH—A method of hardening glass by heating in a muffle to a temperature of about 400° C., and afterwards plunging in a bath of soot or melted butter.

BOISTEL and LEGER—A process by which liquefied metals or alloys having fusing points below that of glass, as copper, lead, antimony, &c., are used for the same purpose. An addition to the patent provides for the employment of currents of gas or of heated or superheated vapours of suitable temperature for the like object.

The same patent a process of "tempering" ceramic wares of all sorts, with a view to increasing their powers of resisting fracture. *Revue Indust., 4th August*, 1875.

Glass Manufacture in Sweden.—According to the statistical report of the Swedish Chamber of Commerce, there were in Sweden, in 1873, in all, 31 glass-making establishments. These gave employment to 1,671 hands. The declared value of their manufactures during the year was 2,833,183 kr., which was 549,885 kr. above that of the previous year, and 1,063,409 kr. in excess of the annual average of the five-year period preceding. The Swedish exports and imports of glass during the year 1873 were as follows:—

	Export.		Import.	
	Quantity. centners.	Declared value. kr.	Quantity. centners.	Dec. value. kr.
Bottles, flasks, jars, &c. . .	22,442 sk. p.	269,304	8,684 sk. p.	104,208
Window-glass .	37,495	3,750	2,232,541	223,254
Other sorts . .	26,149	19,612	280,295	175,997

Teknisk Tidskrift (Stockholm), April, 1875.

TO MAKE GOLD AND SILVER INKS.

GOOD bright gold, silver, and bronze inks are seldom met in the market; they are almost always of a dull colour, do not flow easily from the pen, and the writing remains sticky. Hence architects and artists mostly prefer to use shell gold and shell silver (*Muschel-Silber*), instead of the corresponding ink. The latter, however, is so much easier and safer to use, that I will describe its preparation.

For gold ink it is best to employ genuine gold leaf, but owing to the expense this is seldom used; sometimes mosaic gold (sulphide of tin) or iodide of lead is employed, but almost always Dutch leaf.

Owing to the relatively low price of silver, genuine silver foil is used for silver ink; false silver foil is seldom used, and is not so good. For other metallic inks, commercial bronze powders are employed. The genuine and false foils are also sold in a finely pulverized state; they are made from the waste of the gold beaters by rubbing it, in metallic sieves, to an impalpable powder.

In consequence of the beating between gold beaters' skin, it has particles of grease and other impurities attached to it, which must be removed before it can be used for ink. For this purpose the whole sheets, or the commercial bronze powder, are triturated with a little honey to a thin magma on a glass or porphyry plate with a pestle, as carefully as possible, as the beauty of the ink depends essentially on this. The finely rubbed paste is rinsed into a thin glass beaker, boiled for a long time with water containing a little alkali, frequently stirred, decanted, well washed with hot water, and dried at a gentle heat. By boiling this powder with water containing sulphuric, nitric, or hydrochloric acid, different shades can be imparted to it.

Next, a solution of 1 part of white gum arabic in 4 parts of distilled water is mixed with 1 part of potash water glass, and triturated with the requisite quantity of purified metallic powder. Gold ink will bear more liquid than silver ink, since gold covers much better; on rough paper more metal is necessary than on sized paper; on light paper more than on dark, to make the colour of the ink appear equally intense.

In general, 1 part of foil is enough for 3 or 4 parts of the above liquid. In preparing large quantities of ink, a low porcelain measure is used for transferring it to the small glass vessels where it is to be kept, and it must be continually and thoroughly stirred, so that it will always keep well mixed. It requires frequent stirring also when in use. It is best to mix the dry powder with the liquid immediately before using. The ink can be used with a common steel pen, and flows very well when writing slowly, but it is better to use a pencil.

I consider the use of potash water glass of great importance. It greatly increases the metallic lustre on paper, prevents its looking dead, protects the writing from being discoloured by the action of the atmosphere, and also prevents its penetrating too far into the pores of the paper, without rendering it very viscid. Although the writing of itself possesses a high metallic lustre, it may be increased by gently polishing with a polishing steel. Inks made with mosaic gold, mosaic silver, iodide of lead, &c., are not nearly so beautiful.—*C. H. Viedt.*

BOUHEY'S RADIAL MACHINE.

THE accompanying illustration, for which we are indebted to "Stummer's Ingénieur," represents, on a scale of $\frac{1}{20}$, one of the most important machine-tools in use at M. Bouhey's works, at Montzeron (Côté d'Or). It will be seen that it is a radial drill, which admits of any description of movement that may be requisite in working up metal.

Our readers know the value of machines of this kind, particularly in railway work, as they allow rows of rivet-holes to be cut with an expedition and accuracy which it would be very difficult and extremely expensive to execute in any other way. We shall not descant upon its merits, as the figure shows, at a single oblique view, the details of all the more important parts of the machine.

Its large proportions and the excellence of the arrangements entitle it to a prominent place in our gallery of machine-tools. We have more than once before had occasion to speak of the excellence of M. Bouhey's work and of the leading position he has taken in his own particular line.

CONCRETE SLAB COTTAGES.[1]

THE economical construction of cottage dwellings is a subject which has of late years received a great deal of attention, but it must be admitted that the practical results hitherto attained have not been sufficient to satisfy either the philanthropist or the capitalist. It is essential to a successful solution of this question that a labourer's or artizan's cottage should fulfil the following conditions, viz.:—1. It should contain the requisite accommodation for a man and his wife with a family of say four or six children, separate sleeping apartments being provided for the boys and girls. 2. The cost of construction should be so moderate as to admit of the cottage being let at such a rent as can be conveniently paid by the tenant, and yet yield a fair return for the outlay. 3. The mode of construction should be such as to avoid the necessity of frequent repairs. To these three principal requirements others of minor importance may be added, such as facility of construction without the aid of skilled labour, and also that the external appearance of the structure should be such as to please the eye without necessarily involving any great cost for ornamentation. It has been abundantly proved that proper accommodation for a labourer and his family cannot be provided at a suitable rent in cottages constructed in the ordinary manner, and of the materials usually provided for the purpose. £250 appears to be the ordinary estimate for a pair of brick-and-timber-built cottages, with slated or tiled roofs; and, although this sum may be considered a moderate price for the work done, there can be no doubt that it is in excess of what can usually be afforded for the purpose. When from the probable rent to be obtained are to be deducted rates and taxes and the cost of repairs, it will be evident that cottage-building, under such conditions, is not likely to become a very attractive investment.

The construction of the walls of cottages in concrete instead of brick has of late somewhat reduced their cost, but the use of this material involves the construction or purchase of a somewhat costly apparatus, and the walls, when erected, must be stuccoed, thereby requiring the aid of a skilled artizan.

By a plan recently invented and patented by Mr. W. H. Lascelles, of Bunhill Road, London, he professes to be able to dispense almost entirely with skilled labour, the assistance of a carpenter only being required to set up the skeleton framing of the structure. The framework of the building is constructed of wood much in the same way as the framework of a timber-built or lath-and-plaster house, except that the vertical standards or quarterings are about 3 ft. apart, instead of 1 ft. 6 in. or less, as is usually the case in wooden houses. The walls are constructed of concrete slabs about $1\frac{1}{2}$ in. thick, made of fine ashes, or breeze, or crushed coke, with a proper proportion of Portland cement. The slabs are made about 3 ft. long by 2 ft. wide, and are cast in moulds, iron rods being imbedded in the concrete, to strengthen the slabs, which are faced on both sides so as to require no further finishing. The face of the mould may be so prepared that the outer face of the slab would look like wall tiling, and a suitable colour may be added to the concrete to assist in giving this appearance should it be desired. The slabs are rebated at their sides and ends so as to fit into each other, and they are fixed to the uprights of the wooden framing by means of screws, the joints being made tight with cement. The inner partition walls are made of the same kind of concrete slabs, finished smooth on both sides. The ceilings and floors are also made of the same kind of slabs, but finished smooth on one side only. The roof is constructed of similar concrete slabs. The slabs may be easily cut with a saw, so that they may be used to form the chimneys, which are pargeted on the inside.

The patentee claims that this mode of constructing cottages possesses many advantages; not the least of which is, that a dwelling of neat and even ornamental appearance may be constructed at a cost much less than one built of brick in the plainest manner, as there is a great saving in the weight of materials used, the mere carriage of which is an important item in some places. Another advantage is that increased space is obtained both in walls and in roof, and cleanliness is insured, as there will be no hollow spaces to harbour vermin. Dispensing in a great measure with skilled labour is also an important point, as one artizan to prepare and set up the wooden framework is the only skilled man that will be required; mixing the concrete, filling the moulds to form the slabs, and screwing the slabs to the wooden framework being simply labourers' work, in which they soon become expert. Mr. Lascelles is constructing several cottages at Croydon on his plan, which certainly appears to deserve inquiry.

[1] "Builder," August 14th, 1875.

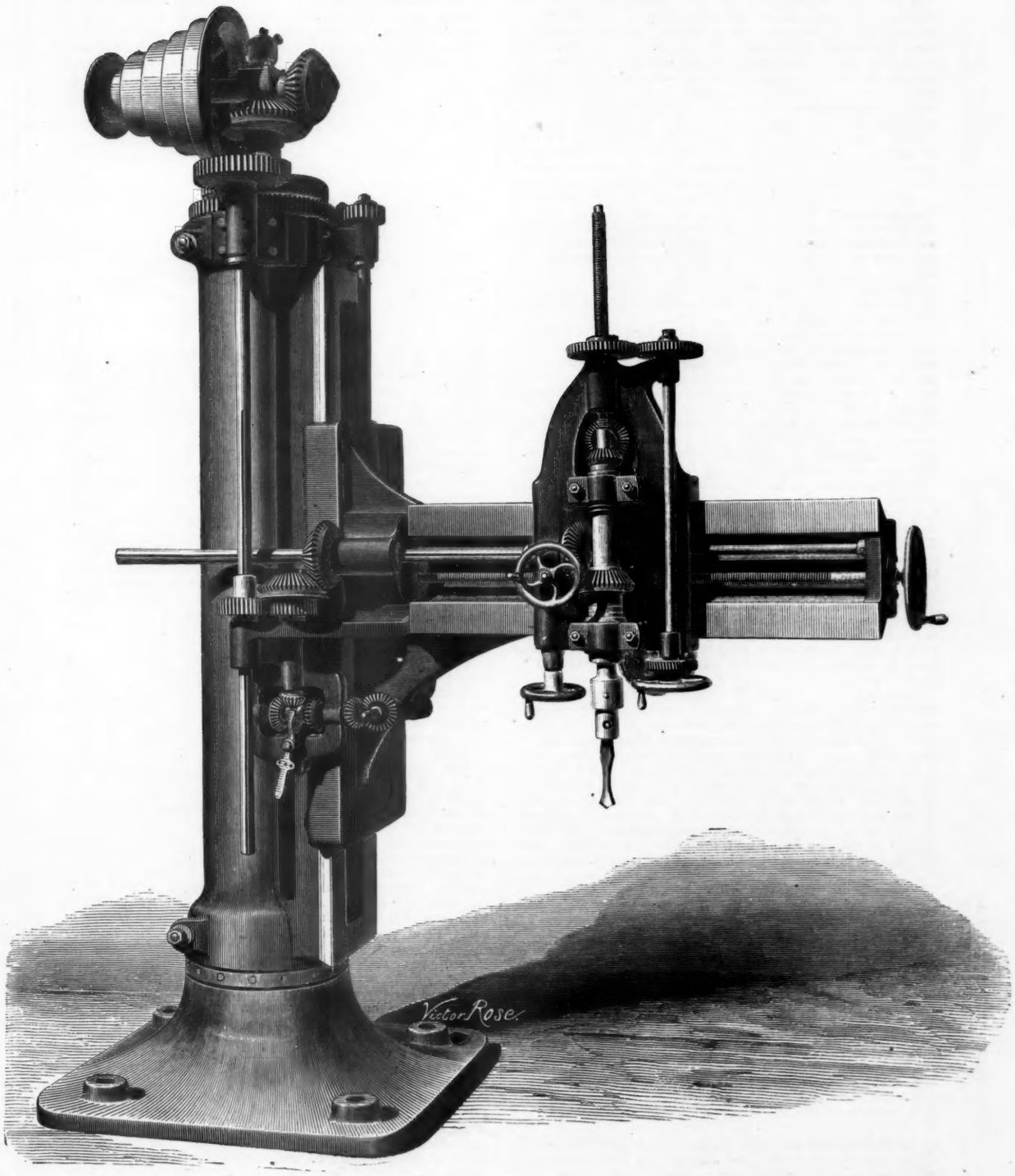
THE HARVESTING AND STORING OF GRAIN.

II.

UPON the first of the papers under this heading, given in our last number, we pointed out the general features of the subject, and showed its great importance from a national as well as a farming point of view. We now proceed to enter into some of the practical details of the question, previous to which it will not be out of place to draw attention to the fact that, as a rule, throughout the country, our cereal crops are not cut early enough—that is, they are allowed to stand in the ground too long. It is somewhat unpleasant to have to record the fact that remarkable ignorance prevails, and that widely, as to the scientific aspects of this department of farming. By allowing the cereals to remain till they are over-ripe, not only is the quality of the grain deteriorated, but also that of the straw. This is not the place to enter into the details of the question, which are too purely of an agricultural nature for our pages; suffice it to say, that we could, if necessary, prove the above statements. As a practical rule, easily remembered and as easily carried out, as soon as the straw at the *upper part*—that is, below the ear—begins to turn yellowish, the corn should be cut; all standing after that is loss, and only loss, to the farmer.

As we are writing for readers other than farmers, although for the latter also, we shall have to give here and there explanations which would not be otherwise necessary. The harvesting of grain, then, resolves itself into two departments: its treatment in the field, where it is first cut and then tied up into bundles, each of which is called a "sheaf," then set up to dry, a number of "sheaves" being placed together in different fashions, according to the custom of various districts, the combination being generally called a "stook," "stitch," or "shock." When sufficiently dried, the "stooks" are carted into the straw or rick-yard, and built up, so to say, into large forms, varying again as to shape and size according to custom, these being called "stacks" or "ricks," these being placed at certain distances from each other in the straw-yard, also called from the above names the "stack-yard" or the "rick-yard."

Beginning at the beginning, we pointed out in last number that a great deal of the after condition of the grain depended upon the way in which the sheaves were "stooked." It is ob-



BOUHEY'S RADIAL MACHINE.

vious that if, after being cut, the grain is put up in such a way that it is least exposed to the drying winds which may blow through and amongst the sheaves and most exposed to such rains as may fall, the condition of the grain will be very different from that where the stooks have been put up so as to be sheltered from wet, yet left open to drying winds. There are many ways in which grain is stooked in the field, but a good deal depends upon the state of the weather. In fine, settled weather, with sun and moderate breezes, corn harvesting is an easy matter; like hay, in similar circumstances, as the saying is, it "almost makes itself." But in rainy weather the work is very harassing, and the method of setting up and the harvesting throughout vary according to circumstances. In such weather the sheaves are generally made lighter, and the stooks less, and often "hooded," which will be presently explained. With light crops the stooks may all be disposed on the crown of the "stitch;" but where the crops are heavy, and the number of stooks greater, and they have to be placed between the stitches or in the furrows, great care is requisite in order to place the sheaves so that they will ride over the furrows—where, of course, the water is sure to lodge—or to bridge them, as it were, spreading out the bottoms so that a row of sheaves will rest on the side of one stitch, the other row on the side of the other.

"Stooking" or "shocking" may be divided into two classes, the longitudinal and the circular. In the former two rows—four or six—of sheaves are placed on each side, the feet spread out, the tops leaning against each other, thus making an inclined heap, so to say, with an open space from end to end at bottom, through which the wind may blow, the sheaves being also slightly inclined in the reverse direction on each side, so that the wind can also blow through the stook, across it, or in its shortest direction. Sometimes the ends are finished off with a sheaf, but this obviously closes up the ventilating opening running longitudinally. In the circular method the sheaves all converge to a central point, being placed sloping all round. In both methods the point aimed at is to give the combination of sheaves such a firm foundation that they will not be easily blown over, and to have them at the same time so loose that free ventilation can be secured. When the weather is thoroughly settled and fine, hooding or capping need not be resorted to, as it saves a good deal of time; but if it is "catching" weather, as the phrase goes, it is by far the better way to hood the stooks, for, if rain comes on and hooding has to be resorted to, there is so much time taken up, that many of the stooks get so thoroughly wetted, that it is useless to hood them. Stooking and hooding them in catching or unsettled weather should be carried on simultaneously.

"Hooding" or "capping" consists in having a series of sheaves covering the upper part of the stook, these sheaves being reversed in position, end up, and opened out as they are placed on the top of the stook, so that the grain and straw shed equally over on both sides of the stook, the grain hanging downwards. It may be described as a species of thatching. When the weather is thoroughly wet, and likely to continue so, each time of fair weather should be occupied by cutting, but only a small portion at a time, so that stooking can be gone on with regularly; and we would in such circumstances recommend the round method of stooking as the best, the sheaves each being small and hooded, as in fig. 1, by a "heading" stitch cap, *b*. Grain put

Fig. 1.

up in this method we have known to stand for weeks in rain which scarcely ever ceased, and although the outer hood or cap grain had so sprouted that the stook was "green as a field," when the good weather came, and the hood was taken off, the sheaves below were in capital condition. One farmer states, who tried this method, that his corn so treated "came out as bright and fresh as in any year." This method is a modification of that adopted abroad, and known as the "moyette," having been introduced so early as the year 1822 by De Vaux, and so strongly recommended by the celebrated Dombasle, that its use became very general. In this method the corn is not put up into several sheaves, but a pretty longish single one forms the central part, this being covered by the hood or cap sheaf, as shown. The first point in hooding in this method is to have the tops of the sheaves forming the stook, *a a a*, fig. 2,

Fig. 2.

brought all as near to a point as possible, with the ends having a perfectly firm seat on the land. To insure this, the sheaves should be pressed down, and the hood sheaf, *b*, should be put on, so that it spreads its straw equally on all sides. The operation is likely to be more quickly done, and certainly better done, if the sheaves are smaller than those used in dry seasons. Where the round stooking, as in fig. 1, is adopted, the hood sheaf should be the largest. In our last paper we alluded to the plan of "unhooding" the stooks in fine weather, so as to allow the sun and air to gain access to the sheaves below; but this method is strongly condemned by an eminently practical man, who says that he finds that, if the hoods are left on, no matter how long, the grain will be taken out in good condition, as we have above stated; whereas, if they are taken off, the alterations or changes of condition seems to have such an effect upon the grain that it is never so good; besides, the risk is run of being caught in bad weather, when more mischief will be done in a few minutes than all the good—that is, if any good be at all effected—obtained by the exposure of the lower sheaves to sun and air for hours.

There are many points which the farmer has to attend to before he can be certain that his corn is in proper condition to be taken to the stack-yard to be stacked; but, as these are more farming details than those we are now concerned with, we pass them over, and assume that the corn has been "led" from the field to the straw-yard and stacking about to be commenced.

That this is an important operation, and one which requires to be well done, we need scarcely say, if one considers the length of time during which the grain may have to remain in the stack, the enemies—as vermin and the like—to which it is exposed, and the chances of its being spoiled, or greatly deteriorated in quality, by being over-heated, &c. Stacks are made of all sizes, some, especially in the southern parts of the kingdom, being very large; small stacks are better, however, than large ones for obvious reasons, the air getting better through them, &c., &c. As to form or shape, the circular we believe to be better than the rectangular, but in both cases the tops or roofs, so to say, are sloped off, and regularly and carefully thatched. If circular, the diameter should, for wheat, not exceed 14 ft. Barley should be the least sized of all stacks, 10 ft. being the maximum; while, for oats, the mean between wheat and barley should be the maximum diameter.

The stacks should in all cases be raised from the ground; and the best method for securing a good foundation is to use the cast-iron rick-stands now so largely adopted. These are made up of a series of cast-iron vertical standards, with broad base and with hooded or capped tops. These hoods are like what may be called inverted bowls, hollow in the inside and rounded at the outside. By this arrangement no vermin can get up to the stack, as they cannot pass round the hollow inside of the cup, even if they are able to climb up the vertical stalk, and which they are not likely easily to do. The tops of the hoods are slightly flattened, and made with slots or openings to receive the ends of iron or timber beams which go across from one standard to another, and which makes the bottom or foundation for the corn to rest upon.

To prevent over-heating of the grain, it is essential that all stacks should be hollow in the interior, the hollow extending from bottom to top. There are several methods in use for ventilating stacks by thus making them hollow. The old-fashioned

way, and one still most extensively used, is the stathel or staddle system, as it is called in the north. This consists in placing wooden erections, as in fig. 3 : these open up the centre of the stack, and, reaching from the bottom nearly to the top, permit of free ventilation throughout the mass. The ventilation through the extreme upper layers of the stack, and of the outer thatching, is found to be effected in the natural way. These wooden structures are of different shapes or forms, another being shown in fig. 4 ; but the object of all, of whatever form, is to keep the interior of the stack open, so that currents of air can pass

Fig. 3.

efficient will be the ventilation through and amongst the sheaves ; and the greater, therefore, the diameter of the stack, the thicker must be the walls, so to call them, of sheaves surrounding the interior framework, as in the figures just given ; and the further, therefore, the air will have to travel from the outside to the inner open space ; and the more difficult will it be to keep up the continual currents of air, which it is the object of the arrangement to secure. These considerations would, therefore, militate strongly against the plan of some farmers who maintain that you cannot make your stacks too large. It is impossible, or almost impossible, to lead corn from the field so thoroughly "won," as the technical phrase is, or dried, that there shall be no moisture in it. Now, when the

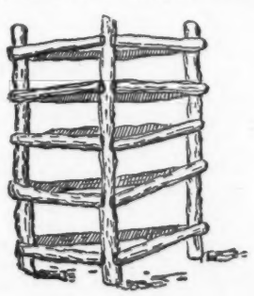


Fig. 4.

sheaves, containing this moisture to a greater or less amount, are placed in mass in the stack, it is the evaporation of this moisture which, when it cannot gain access to the outer air—in other words, get freed from the interior of the stack—that causes over-heating ; and it is scarcely worth the demonstration that—to use a familiar phrase—it will take longer for the moisture-laden air to travel ten than it will take to travel five feet ; and that it is likely to meet with more obstructions to its free exit in the greater than in the lesser length.

If stacks were so constructed that free ventilation in all directions was secured, it would not matter much how large they were ; and a plan to secure this was some time ago proposed and carried out by a Mr. Smith of Darnack, N.B., which was through the sheaves. They usually rest upon horizontal tressles, which keep them off the ground, and still further assist ventilation. The only objection to these is, that the currents are too apt to be formed in one direction—the vertical only ; hence, if some method of having lateral openings communicating with the vertical one could be arranged, a more thorough system of ventilation throughout the mass of sheaves would be secured. This, to a certain extent, will be attained by keeping down the diameter of the stack ; for it is obvious that, the further the air has to travel in a lateral direction, the less

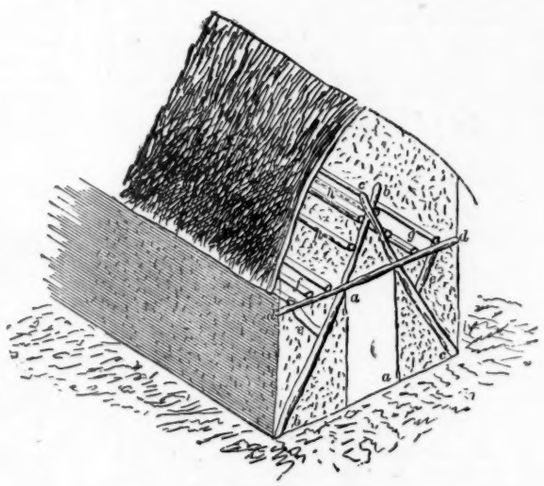


Fig. 5.

found in a large measure effectually to secure this. The above rough diagram (fig. 5) will show the general arrangement of Mr. Smith's system of stack construction, the principle of which may be said to be, first, the making of a longitudinal air-way or ventilating channel, so that the stack could be made of any length ; and, second, the building up of the sheaves above and around this, that the shortest way from this interior channel to the outside was secured or nearly so ; while, from the way in which the timbers were trussed, the downward pressure arising from the weight of the upper portion of the stack is prevented, and which pressure is in the majority of cases very difficult to meet, and is the cause of that compression of the lower sheaves together which hinders so much the free passage of the air through them, and which plans such as in figs. 3 and 4 are not calculated to prevent. From the sketch in fig. 5 it will be seen that a central opening or space is left from end to end of the stack—which may be made of any length—and that this is made by the arrangement of the diagonal timbers *b b*, *c c*, crossing at the top, and secured there by a band or rope. Longitudinal spars as *h h* are to be nailed near the top of these diagonal timbers *b b*, *c c* ; but those marked *f f*, *g g*, resting on the horizontal rafters *d d*, are designed to be movable, and are not placed on the rafters *d d* till the corn sheaves reach this height. The downward pressure of the corn at the top of the stack is relieved or got rid of by the employment of the diagonal struts or braces *e e*, which are connected at one end to the horizontal rafters *d d*, and the diagonal timbers *b b*, *c c*. The dotted points show the ends or positions of the sheaves. The width of the stack is arranged to be some 12 ft., the height of the central opening *a a* some 6½ ft., and the width about 3½ ft. By the employment of rough home timber, the wood-work may be put up at a cost varying from 3*s*. to 4*s*. per lineal yard, according to circumstances of locality, cheapness of labour, &c. The great advantage of the plan is the having of a central opening from end to end of the stack, by which not only a perfect thorough draught longitudinally can be secured, but a capability of inspection of the condition of the grain, also a point of great importance. The plan would be greatly improved, we incline to think, by having cross openings at intervals in the length of the stack ; these could be very easily arranged for by vertical timber and short diagonal struts. These need not open quite at the sides of the stack, but stop short a short distance therefrom ; this would insure the ventilation required, and also enable the condition of the corn to be examined. There are ob-

viously many modifications of the principle, which carries with it not a few important points worthy the attention of practical men.

Somewhat on the same principle, but by no means securing such a hollow condition of stack, is the plan proposed by Mr. Usher; but the chief point aimed at in the plan is to relieve the lower part of the stack, as *a a*, from the presence of the upper part *b b*, thus keeping the sheaves in the lower part quite free and open throughout; and this to such an extent, that in practice it is found that each straw, as it were, acts as a ventilator, being so loose and free from the pressure on it of the upper straw; thus, in fact, getting rid of the great evil in ordinary stack building, where the pressure of the upper sheaves compresses the lower ones so much that they become a solid mass, so to say, through which little or no air can pass. Mr. Usher obviates the evil by supporting the upper part of the stack on timber, *c c c*, not in the sheaves of the lower part, but by the arrangement shown in fig. 6. In addition to the loose state of the lower sheaves relieved from the upper pressure, it is found that there is a subsidence of the whole lower portion, *a a*, to such an extent that an opening of some inches is found at or near the level of what may be called the timber flooring, *c c c*, which, being at the very thickest, are, in stacks as usually formed, the very densest part of them, and admit of an amount of ventilation, which is highly beneficial. The principle, therefore, on which stacks are thus formed may be said to be a "self-acting" system of ventilation, which, taking advantage of the weight or pressure of the grain in ordinary cases, the source or cause of the evil, forces it, so to say, to be the very means of getting rid of it, thus making the "enemy fight himself," and, what is the best of the business, conquer himself. The diagram requires but little explanation; the timbers used may be of the roughest, the method of fitting them up the same, so that security be attained; the stack may be made of any length, the best breadth being found to be about 14 feet, the height of the posts up to what may be called the timber or dividing floor being 10 feet, the distance between the vertical posts being 14 feet, so that the framework is erected in 14 feet squares. Mr. Usher states that, in ordinary weather, corn may be safely stacked on his system after being in the field only for one half the usual time, so that the chances of being "caught"

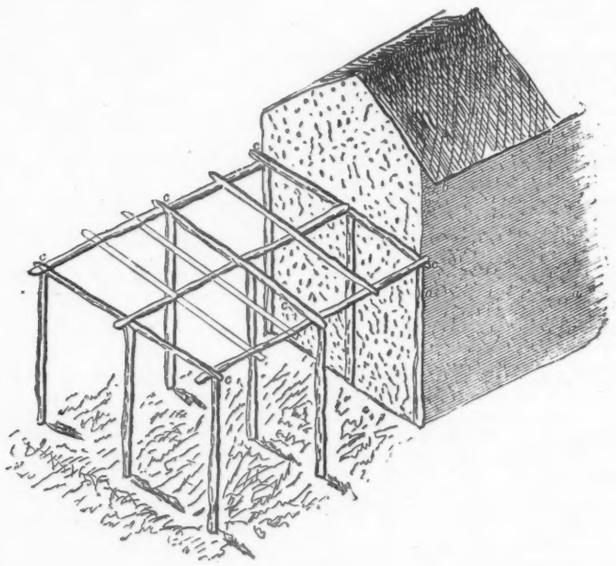


Fig. 6.

in bad weather are very greatly reduced; and further, that, after being stacked, it is brought much more quickly into a condition ready for the market. It is obvious, moreover, that the time saved, and of course the expenses, in heading or finishing off the stack at top is considerable as compared with a round stack, two sides only in the new system being required to be headed in place of all round as in the other plan. The expense of erecting the framework is in itself comparatively a mere trifle, as any kind of rough timber will do, which will, he also states, be saved in the course of a year or two, by the mere difference in the cost of stacking, finishing off, &c., to say nothing of the increased value of the corn. The whole system, so far as the keeping up of currents of air throughout the grain, lies in the relieving of the lower layers of corn from the pressure of the upper, by the introduction of the timber flooring in the centre of the stack; and it is, therefore, a question whether the advantages would not be increased by adding to this relieving principle, by giving more than one row of horizontal timber. Mr. Usher, however, obviously relies upon the importance of relieving the pressure at the point where it is most felt, about the centre of the height of the stack; and there is no doubt that, by putting in too many horizontal timbers, the difficulties of stacking would be increased, and also of unstacking, as the timber would come in the way of the pitching-off forks.

The plan of having rick or stack-yards wholly covered in has been very much advocated by some of late years, and there is no doubt but that many advantages would arise from it. At the same time the difficulties attendant upon the carrying out of the plan must not be overlooked. The structural ones are in themselves of no mean order; not that we mean to infer that roofs of any span calculated to cover areas sufficiently large to take in the whole of the grain of the largest farm cannot be constructed; but one has to look at all the points of a question, and one would be, and is, the expense. That the housing of grain carries with it many advantages there is no doubt, and in severe climates it is essential, as we find in the farms of the United States and of Canada, with their immense barns, as well as on the Continent; there is no likelihood of this "barn" plan being adopted in this country, but its advantages being so great has led many to conceive of a modification of it; hence the proposed plan alluded to above of having covered rick-yards, that is, spaces roofed in but open at the sides in which to store up the grain, which, in bad weather, could be very quickly secured from its effects. But, as we have said, there are many difficulties in the way of carrying this plan out; hence another modification has been proposed, and in one farm, and that the most extensive and most splendidly *engineered* in the kingdom, has been carried out with singular success. It is well known that narrow-span roofs are much more cheaply constructed than wide ones; these narrow spaces do not, however, afford the same protection to the grain as wide ones; but by having the roofs narrow, or comparatively so, and the necessarily narrow spaces still well covered in or protected from the weather by the cheapest possible inclosing walls, it is obvious that all the advantages of having roofed-in areas of large dimensions can be attained. Now the cheapest possible inclosing wall of a rick-yard is clearly the straw sheaves themselves, the sheaves being placed under the roof in such a way that their ends only shall be exposed to the outside, their heads being all inward and the grain, therefore, thoroughly secured from all bad weather. This "happy

thought" has been carried out in the farm alluded to above, namely, that of Luton Hoo, the property of Gerard Leigh, Esq., by the exceedingly talented manager of the farm, Mr. Ross. The plan is simply roofing in a space (in this case it is nearly 500 feet long by about 36 feet broad), and building the sheaves in the way above named. To prevent "vermin" gaining access to the grain, a low wall, some two feet high, is built all round the space. The upper part of the wall is capped or covered over with zinc, and which comes down two feet in front; this smooth surface is one up which no rats can climb; but a better plan would be to finish the top with a zinc cap projecting from the upper part, and concave in form; the rats may climb up the wall, they cannot, however, pass under the smooth and hollow surface of the zinc capping, but have simply to fall down. Another advantage obtained from this system of housing in *unthrashed* corn is that it forms also a first-rate shelter shed for the thrashed straw,—a point of great importance where the shed is near the cattle houses, as it should be, and where the arrangement of the building does not provide for the central barns, the corn and straw barns, which some buildings do not.

In a short series such as the present is, we cannot possibly glance at all the points of the important subject we have taken up and in the briefest way discussed; but we cannot dismiss it without noticing another point, and that of no small practical importance. We have shown the different methods of treating the corn in the stack-yard; but we have not yet noted the fact, that in practical farming it is a disputed point *where* the stacks should be—one system being that which we have already described, the taking of the corn to the stack-yard, which is situated quite close to the general farm buildings, as near to the thrashing barn or "corn barn" as it can conveniently be placed —the other system being the building of the stacks in the field, and thrashing the corn there by means of a portable engine, and thereafter either building up straw stacks, from which supplies of straw are taken to the cattle houses at the farm buildings to be used as required; or at once, after being thrashed, leading the straw to the farmyard, building straw stacks there, or storing it up in barns if these be part of the buildings. This second system is rarely, if ever, to be met with as forming part of the farm practice of northern districts, being as a rule met with only in the south districts, and in part only of these. The two methods, where they are both met with in the same districts, have given rise to discussions of the warmest kind; although it is not easy, we confess, to find many, if any, cogent arguments in favour of the plan of field stacking and thrashing; the only or chief one being this, that in uncertain or "catching" weather one has less chance of being caught in a shower or in showers by stacking the corn, as soon as ready to be stacked, in the field where it has been reaped, than when it has to be "led" perhaps for a considerable distance from that field to the stack-yard at the farm buildings. The other argument, if it be one, in favour of the system is that by bringing a portable engine to the field grain can be thrashed out at once, and then "taking one's own time" to lead the thrashed straw to the fold yard or the straw barn. But, not to lose time in meeting these arguments, it may be questioned whether time is really saved by this system—for the straw is not to be used either for folding or feeding in the field, but in the fold and in the cattle houses; so that you thrash it out at a place where it is not wanted, and then you have to lead not only the straw to the place where it is wanted, but also to cart up the grain to the granary, which is not in the field, but at the buildings. Then, again (and we think after stating this we need say no more), one has but to contrast the slovenly way in which grain is thrashed in the field, with the straw blown about in every direction by such winds as may be blowing (and wind more or less in this "breezy land" of ours may be reasonably expected almost at any time), with the neat, orderly way in which it is "house thrashed," in which the thrashing machine delivers the thrashed straw to its final place of deposit in the straw barn as soon as it is thrashed and the grain in the granary; and last, but not least, compare the risk of fire which one runs by thrashing in the field. Wise men usually try to keep the cause of fire, and the material likely to be fired or burned, separated as much as possible; in this system the opposite plan is adopted, and they actually bring the two opposing and dangerous elements together, and as closely together as they can well be, and under circumstances, as a breezy day, when loose straw may be blown in upon the engine fire-place. Then, and really now to conclude, it may be questioned whether time is saved by the system of field thrashing—we know what men's habits are, and a readiness to finish off this work at once is not one of them too often met with. We have seen straw which has been field thrashed laying out in the field in the loosest way, no attempt at stack forming, except in the roughest, loosest possible way, being even attempted weeks after the thrashing has been done, one excuse after another being brought forward why the straw could not be "led" to the farm buildings. We therefore have no hesitation in condemning the field system of thrashing, as thoroughly bad in principle and as productive of grave evils in practice.

In a series of papers on the "harvesting of grain"—which in its evident acceptation involves, as we have seen, its proper housing and securing, so that grain well reaped and "won" in the field shall be stored in such a way that its good qualities be retained—we cannot ignore the "artificial harvesting" to which such prominence has been given, as can be given, by the offering of a special prize—which we have already noted in our report of the "Leading Agricultural Shows of the year"—by the Royal Society. The system and plans by which it has been proposed to carry it out efficiently in practice is by no means a new one, nor have the plans been few or lacking in ingenuity. So far from this being the case, and so much that is really interesting in a popular, and useful in a practical sense, has been brought out in connection with the system, that we feel assured our readers would be so gratified and instructed by a review of what has been proposed and done, that we shall devote, at an early period, a special paper to it. Meanwhile, it is right to conclude this paper by describing very briefly the one method now in use in more than one district for effecting what is called "artificial harvesting." This is the invention of Mr. W. A. Gibbs, of Gilwell Park, Sewardstone, Essex, and is something more than a mere "project," it having proved itself a success in more ways than one. The system is worked in two ways, the "fixed" or "permanent," and the "portable" one. The latter we shall describe as generally used, and as briefly as the now very limited space remaining to us affords.

Air heated artificially is the medium by which the hay—for we shall describe the hay-drying apparatus first—is dried or harvested, this being obtained by passing all the air, by means of a small fan driven by the portable steam-engine, through a stove, which is heated by coke or charcoal, so that, as no smoke is generated, all the products of combustion are used for drying purposes. To the heated products of combustion obtained from the interior of the stove are added the volumes of heated air produced by passing air through a chamber surrounding the interior stove, so that the united temperature of the two currents amounts to somewhat about as high as 360°. The heated air thus produced, and which by the way may be cited as a very economical method of producing such highly heated air—is driven by the fan into a trough or chamber which, placed at an angle, resembles the trough of a stack or straw elevator, and the floor of which has given to it, by simple yet most ingenious means, a reciprocating, or to-and-fro action, which gives motion to the grain as it passes along the chamber, and helps to bring it under the action of the hot air. The bottom of the trough is divided into two longitudinal parts by a ridge running along its centre, and dividing it into two semicircular channels or troughs. Into these troughs the heated air is admitted by slots or apertures, one on the one side of the central ridge, the other series on the other side of it, so that the heated air passes from the lower part of the trough through these apertures on each side of the central ridge. The hay or straw is fed at the upper part of the trough, the angle of which is adjusted by a cleverly constructed screw-jack, and travelling down the trough is subjected to the action of the heated air passing through the apertures named above, and which is further aided by the hay having a slight lifting motion given to it by a series of tines or forks so contrived as to imitate the action of those worked by hand.

Such, without going into mechanical details, which are quite worthy of the notice of a special paper, is a general description of an apparatus which has taken the patient labour of years and the expenditure of, we believe, thousands of pounds to bring it to its present position, and which has proved itself no mere scheme, but a workable plan, capable of turning out daily an enormous quantity of dried material, whether that be in the form of hay or unthrashed grain.

SWISS EMBROIDERY.

THE United States' consuls in Switzerland report a remarkable increase in the export of embroidered cotton goods, chiefly the produce of St. Gall. Ten years ago the export to America was only £23,060, while during the past year it exceeded £400,000; it is also further stated that the manufacturers have orders in hand for American houses which will employ all their available labour for the next twelve or fifteen months.

There are two distinct articles, hand embroidery and machine embroidery; the former gives employment to upwards of 12,000 persons, mostly women and children, with wages varying from 1*s.* to 2*s.* per day. Hand embroidery consists of cotton, twill, and muslin, used for curtains, handkerchiefs, and numerous articles of ladies' dress. The tulle used for groundwork is imported from England, or from neighbouring factories in Alsace.

Machine embroidery gives employment to nearly 20,000 persons. Each machine is worked by an able-bodied person, and a female assistant to thread the needles, with an additional assistant for every two machines to mend defective places. Wages are paid per 100 stitches; the price of labour, varying according to the skill of the operator, averages about 4*s.* per day, the assistant female earning about 1*s.* 3*d.*

The machines are of an exceedingly ingenious character, increasing the rapidity of working over the old machines, as well as giving greater variety and richness to the design. The needles have a point at each end, with eyes in the middle, and are attached to a kind of carriage. They travel over the web, passing the threads in and out, while pincers take hold of the needle at one end of the web and send it back to the other. Some of the machines are capable of working more than 100 needles at once. Until recently the working of the new system was kept secret, but a machine was exhibited at work at the Vienna Exhibition. In 1868, the number of machines at work was a little over 2,000, while now the number exceeds 6,000. The machines are manufactured by The Mechanische Werkstätte, St. Georgen, near St. Gall.

The best class of goods, consisting of articles of exquisite beauty, embroidered on Swiss muslin, continue to be produced by hand looms.

Engineering, Building, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, &c.

§ 1. *Engineering.*

New Stone Saw.—For six months past M. Degen, of Kriens, has used a new description of saw for cutting free-stone into slabs for window-mouldings, plinths, cornices, &c., with excellent results. The speciality of M. Degen's invention is that the saw itself remains stationary, the work being performed by drawing the stone to and fro beneath it. Several saws are mounted side by side, at various heights, each admitting of a certain amount of vertical displacement and adjustment. The saving in time and labour and the neatness and economy of the work are stated to be greatly in favour of the new principle. It will shortly be protected by patents in various countries. The first machine of the kind was constructed at the works of Darnio, Sievert and Schistor, at Oerlikon, near Zurich. *Neue Deutsche Gewerbe-Zeitung, No.* 14, 1875.

Locomotives for Tramways.—Experiments, attended with fairly good results, have lately been made upon a small private line of tramway leading to the quarries at the foot of Mount Avron, near Neuilly-sur-Marne, with a new noiseless and smokeless locomotive. Unlike the American "fireless" locomotives spoken of in a previous number, which are supplied with steam sufficient to carry them over their journey by fixed generators at the termini, this new locomotive was worked with a mixture of hot compressed air and steam. It was found that 800 litres of atmospheric air, compressed and heated, sufficed to move a car containing twenty-five persons, and itself weighing 4,500 kilogs., over a distance of 3 kilometres. There was no disagreeable noise, no smoke, no escape of steam. The stoppage of the car was very easily effected. In an economical point of view, the results, as compared with horse traction, are understood to have left a good deal to be desired.—*Revue Indust.*, 21*st July*, 1875.

Driving Air with Superheated Steam.—A method of driving air with superheated steam, proposed by M. TESTUD DE BEAUREGARD, is highly recommended by Professor Poillon, of the Industrial Institute at Lille, in the under-named journal. The steam passes from the generator into a suitable vessel, where it is raised to a temperature of 700° C. and a pressure of 4 to 5 atmospheres. This vessel is provided with a certain number of jets, from which the steam is allowed to escape as required. Immediately opposite to each jet is the conico-cylindrical orifice of a pipe, into which the surrounding air is driven by the escaping steam. These pipes converge into a single large pipe, leading under the surface of the water in a reservoir partly filled with the latter. The air, rising through the water, collects in the air-space above, whence it is drawn off through tuyères to its destination as required.

The merits claimed by Professor Poillon for this arrangement are: 1. An enormous volume of air can thus be driven with a very small expenditure of motive power. According to M. Testud de Beauregard, the volume of air set in motion is twenty-one times as great as could be driven by the same quantity of ordinary steam applied to a fan or blowing apparatus. 2. The temperature and pressure of the air can be regulated automatically, and varied at will, whilst its hygrometric state remains constant. 3. Being saturated with watery vapour, the air is deoxodizing, and not oxidizing in its action, like a blast of ordinary dry air, hot or cold. The latter is an important advantage in smelting furnaces. *Moniteur Indust. Belge*, 10*th July*, 1875.

New Boiler.—M. RIOT, a French engineer and an acknowledged authority on questions connected with consumption of fuel, has just constructed a boiler which generates steam of 25 atmospheres, in a safe and regular manner, without superheating. With this boiler M. Riot asserts it will be possible to construct engines of 6 or 8 H. P., without condensers, which shall consume no more fuel per horse-power per hour than the very best condensing engines of 50 to 100 H. P. now in use. No details are given. *Revue Indust.*, 21*st July*, 1875.

New Anti-Corrosion Preparation.—JULIEN patents (France) the following preparation for the protection of the bottoms of iron ships:—

1st Coat:—100 kilogs. benzine, 40 kilogs. colophane, 60 kilogs. gallipot, mixed with 60 kilogs. oxide of zinc, and 40 kilogs. oxide of iron.

2nd Coat:—100 kilogs. benzine, 40 kilogs. colophane, 5 kilogs. paraffine, mixed with 40 kilogs. oxide of zinc, 30 kilogs. oxide of iron, 20 kilogs. binoxide of mercury, and 20 kilogs. linseed oil. *Revue Indust.*, 21*st July*, 1875.

New Cement for Boilers.—AMÉDRO patents this composition for boiler seams:—

Starch	80·30 parts.
Gluten	7·20 ,,
Dextrine	4·62 ,,
Fat	2·75 ,,
Cellulose	3·53 ,,
Phosphate of Lime	1·60 ,,
Zinc white	0·10 ,,
Red ochre	0·15 ,,
Pipe clay	0·10 ,,
Linseed oil	0·15 ,,
	100·00 parts.

Revue Indust., 21*st July*, 1875.

Preservation of Boilers when not in Use.—M. VICTOR SIRK furnishes particulars of a trial recently made at the Austrian Naval Arsenal at Pola, of Burstyn's mode of preventing the collection of moisture in, and the consequent oxidation of steam-boilers when not in use, by introducing therein certain quantities of anhydrous chloride of lime. As a chemical by-product this highly hygroscopic substance is now tolerably low priced, and generally easy to procure. A pair of marine boilers (on board the Imperial iron-clad *Salamander*) each having a capacity of 65 cubic metres, were emptied, and dried by heating until no traces of moisture were perceptible. The port boiler was left empty; in the starboard were laid six iron bars, and upon them 80 kilogs. of anhydrous chloride of lime, forming a heap 1 metre long by 36 centimetres broad and 10 centimetres high. Both boilers were then carefully closed, and at the end of a month reopened and examined. The starboard boiler was perfectly dry, and the chloride of lime was found to have increased 1 kilog. in weight. The port boiler was dry, but showed unmistakable tokens of the presence of moisture on various parts of the interior. A lighted candle introduced therein burned dim, whilst in the starboard boiler the light remained bright and clear. The boilers were left in the same condition for five months longer, being opened and examined at the end of each month. The starboard boiler remained perfectly dry the whole time, and at the end of the sixth month the chloride of lime was found to be deliquescent, having absorbed 48 kilogs. of hygroscopic water. No signs of rust were anywhere visible.

In the port boiler there was a coat of rust nearly half a millimetre thick over the whole interior. It is hardly necessary to observe that boilers treated in this way should not be opened oftener than is necessary. They should be examined once a month, and if necessary the chloride should be dried by roasting, and may then be used again. *Stummer's Ingénieur, 9th July*, 1875.

Vulcanized Fibre.—This is practically a new material, a product of paper or paper pulp, treated chemically, so as to produce some very remarkable results, the product differing totally from the original matter, and it being impossible (by any process yet discovered) to reconvert it into the paper or pulp from which it was manufactured. Like vulcanized rubber, it can be manufactured into either hard or soft goods, or moulded into a variety of forms. In the hard form it closely resembles horn or bone, and can be turned in a lathe, and worked like these substances with a screw-thread cut upon it, ornamented fillets, &c., &c. It is absolutely insoluble in water, either hot or cold, is uninjured by oil, petroleum, alkalies, &c., and is but slightly affected by most acids. It is an excellent non-conductor of heat and electricity, and is remarkably strong, tough, and elastic, and will receive a very high polish. In this form it is used largely for journal bearings, elastic washers, for railroad fish-plates, bolts, gibs for engines, plumber-blocks, pump-valves, carriage washers, powder press-plates for gunpowder mills, and a variety of other uses.

As a journal bearing, it possesses remarkable anti-friction qualities; it is claimed that it will wear twice as long as the best brasses of Babbitt metal, and that it requires very little lubrication, does not heat at any speed, does not cut the journals, no matter what amount of "grit" may be floating around, is elastic, and can be furnished at a less price than any anti-friction metal. It is, we are informed by authorities, now being introduced in locomotive cars, engines, paper mills, and other machinery, with great success. Small bearings from $\frac{5}{8}$ in. to $1\frac{1}{2}$ in. diameter are formed by winding on a mandrel, and then rolling them under very heavy pressure on the mandrel, which insures the interior being circular, and of exact diameter. The tubes thus formed are cut into suitable lengths, and into halves longitudinally, which can be slipped into suitable cast-iron boxes, as linings, in a few moments, and at but trifling cost. We would suggest to parties using machinery of all kinds, and especially such as run at high speeds, to test these bearings. For larger bearings the material is formed in a different manner, but is equally convenient and economical. To show the strength and toughness of this fibre, it is only necessary to state that the "press-powder plates," which are about 24 in. square by $\frac{1}{4}$ in. thick, are subjected to a pressure of 5,000 lbs. per square in., which does not injure them. As plumber-blocks, washers, valves, &c., the material is stated to have proved far superior to leather, rubber, wood, or any other substance now in use, and far cheaper, and is used by many faucet makers in the United States. The carriage washers are also very popular with axle-makers, being uniform in thickness and size, and very durable. The soft, flexible goods are made in sheets like rubber cloth, and used for sockets, union-joints, steam-packing, as well as for roofing, felting, &c. *American Artizan.*

Agrometer.—This instrument, the invention of M. C. HUBERT, of Pornic, Loire-Inférieure, is very highly recommended for general surveying purposes, where extreme accuracy is not essential. It consists of three parts:—1. A portable tripod stand. 2. A graduated circle, with verniers for measuring horizontal angles and adjustment screws. 3. A horizontal metal bar, graduated, and provided with slide and eye-piece, a small spirit-level, and adjustment and clamp screws, which serves as a telemeter. A 12-ft. levelling staff, with sliding vane, accompanies the instrument. Horizontal angles are measured, as already observed, with the graduated horizontal plate, somewhat after the fashion of a theodolite. The heights and distances—horizontal or hypothenusal—of objects, accessible or otherwise, are determined with the graduated bar and slide, by methods that will readily suggest themselves to those acquainted with the branch of mensuration that treats of the determination of heights and distances without the aid of angular instruments. The agrometer, it is said, is very handy and compact, and the details of its construction have been very carefully considered. It admits of considerable accuracy, and an important saving of time may be effected by its employment in land surveys and engineering field work. Suppose a survey of an inclosure in the shape of an irregular polygon to be required. Instead of chaining over the boundary and one or more tie-lines, or using a combination of chaining and angular measurement, it suffices to place the agrometer at some suitable central point, and to set up the levelling staff in turn at each angle of the boundary. The horizontal distance of the staff from the instrument at each station is read off on the bar, and the angle subtended at the instrument by each succeeding pair of stations is read off on the horizontal circle, so that the work can be plotted at once, without shifting the instrument or having recourse to surface measurement of any kind. Again, if a section of the ground be required, the line of bearing can be given, as with a theodolite, and the distances, horizontal and hypothenusal, of the levelling-staff, held at suitable points along the line, can be determined on the bar without moving the instrument.

The price of the agrometer, with levelling-staff complete, is 300 fr. (£14). *Stummer's Ingénieur, 13th August*, 1875.

Micrographic Telemeter.—This very complete and admirable apparatus is described by the ABBÉ MOIGNO as one of the marvels of the Geographical Exposition at Paris. It is the invention of MM. Dallemagne, Triboulet, and Dagron, and is designed to extend the practical applications of micro-photography, of which art M. Dagron may be regarded as the founder. Amongst its chief uses are the following:—1. To provide a simple and rapid method of reducing maps and plans by photography to a sufficiently small size to admit of the carriage of a large number in a very small compass. 2. To provide means for the rapid alteration or correction of the same in the field; it being only necessary to make the addition or alteration with the pen on the original, and to take a fresh set of copies. 3. To provide means for the production, day after day, of large numbers of copies from a single original. 4. To provide simple optical arrangements for viewing the above micrographic maps, &c., so that they may appear enlarged sufficiently to be inspected with ease. 5. To provide for the determination of distances on the same. 6. To secure means of illumination, so that the entire surface of a map so viewed may be lit up by the light of a cigar or lucifer match, a gleam of moonlight, and other insufficient light. 7. To provide for the reading of photo-micrographic despatches in the field. 8. Also means for enlarging micrographic maps or plans to any prescribed scale. 9. Also means for delineating ground by means of a photographic dark chamber used as a camera lucida.

The whole apparatus occupies a little over 3 ft. square, and shuts up like a portable sketching case. It includes an enlarging microscope, a portfolio for the reduced photographic plans, on strips of glass, mica, dry collodion, or other suitable material, measuring 21 in. by 15 in., a frame for mounting the same for inspection, covered with a glass engraved with graduated concentric circles, serving as a scale, and with a small mirror behind, by which the rays of light are concentrated on the map, a photographic dark chamber, with chemicals, &c., &c. In practice the apparatus has been found to give most satisfactory results. *Les Mondes, 12th August*, 1875.

Normal Dimensions of Navigable Canals.—This subject is treated very fully in a paper communicated to the Hanoverian Engineers' Society, by Wasserbau-Inspector HESS. The writer points out the importance of an extension of canalization as the only practical means of keeping in check the irresponsible monopoly of the railways, and urges the necessity of adopting some normal system of dimensions to give increased facilities for inter-navigation, and to secure the maximum of accommodation at a minimum cost. From a consideration of the dimensions of the principal Continental and American canals, and of the conclusions arrived at on the subject by the Central Verein für Deutschen Fluss u. Canalschiffahrt, in 1872, he deduces the following data:—

Normal Dimensions for Navigable Canals.

	Metres.
1. Maximum draught of water for boats	1·75
2. Width of locks in the clear	6·40
3. Minimum length of locks	51·50
4. Width of clear water-way, under bridges	10·00
5. Clear headway, under bridges	4·50
6. Depth of footings below mean water-level	2·50

7. Width of canal, to admit of passage of two boats. Dimensions of aqueducts, tunnels, and locks to be determined by local circumstances. *Zeitschrift für Oest. Ingr. u. Archit. Verein*, 11, 1875, *from Zeitschrift für Hannover'schen Ingr. Verein*, 1874.

Injurious effects of Snow on Steel Rails.—Some interesting observations under this head are communicated from an Austrian line of railway, the Kaiser-Ferdinand, northern line. A portion of this line, about eight English miles in length, betwen Floridsdorf and Wagram, is very open, and often blocked with snow in winter-time. The obstacle is generally surmounted by strewing sand over the rails in front of the driving-wheels to

increase their bite, and putting on extra steam. This portion of the line in question has a double line of metals, formed partly of Bessemer-steel rails and partly of light Martin-steel rails, weighing about 30·50 kilogrammes per running metre. Now, the skidding of the wheels frequently caused heating of the tires and rails, which are suddenly cooled again by the low temperature of the air on the falling snow. This, in itself, must be injurious to the molecular construction of the metal. But, besides, the increased friction causes a certain amount of abrasion of the upper surface of the rails at the spots where the stoppages have occurred. Examinations proved that these abraded portions varied in length from 2 to 9 English inches in length, $\frac{1}{12}$ to $\frac{1}{4}$ in. in depth, and extended over the whole breadth of the rail. A train in passing over the slight depressions so caused necessarily experiences a certain shock, and it is reasonable to suppose that the concussion thereby communicated to the rail will be most felt when the ground beneath is frozen hard, so that the natural elasticity of the rail has no room for play.

In three instances rails so worn snapped asunder suddenly at the abraded portion, although no flaw or defect in the metal could be detected. This led to the removal of all abraded rails from this section of the line, amounting to 28 lengths of Martin-steel rails and 10 lengths of Bessemer rails. No similar case of fracture is known to have occurred in the iron or puddled-steel rails previously in use, although the amount of abrasion they underwent must have been at least as great. The inference is that the improved rails of Bessemer and other steels, their superior strength notwithstanding, are less capable of withstanding concussion than the older rails, and that consequently, whenever they are used, increased vigilance is requisite to prevent accidents in winter-time. *Zeitschrift für Oest. Ingr. u. Archit. Verein*, 11, 1875.

New Process for rendering various Materials Impermeable.—DUJARDIN patents (France) the following process for rendering various materials, such as canvas and other textile fabrics, felt, cordage, drainage-pipes, wood, leather, cardboard, and paper, impermeable :—Pound well in a mortar 335 gr. of sulphate of alumina and potash reduced to powder, with 335 gr. of pyrolignite or acetate of lead. Then add bi-carbonate of potash and sulphate of soda, each 200 gr. When all these are well combined, pour in 120 gr. of calcined sulphate of magnesia, and 5 litres of water. The preparation is placed in a 50 litre tub and stirred until the components are dissolved. It is then poured into a 100 litre tub containing 150 gr. of soap dissolved in 50 litres of water. The material is rendered impermeable by dipping in this material. *Revue Indust., 21st July*, 1875.

§ 2. *Building, Decoration, &c.*

Imitation Marble.—Pichler, gilder and decorator, of Vienna, communicates the following simple method of preparing imitation marble for all sorts of decorative purposes. Mix 1 lb. finely powdered lime into a thick paste with water, and add ½ lb. of colaphane, or, what is better, Venice turpentine. Allow the mixture to stand for some time, and then work up with it suitable quantities of fine white chalk and various coloured earths, adding a few drops of olive oil if necessary. A soft mass is thus obtained, which can be moulded, like plaster of Paris, to any desired form, or it can be rolled out on a warm metal plate, or pressed under wooden rollers, into thin sheets, which can be glued to the surface to be decorated, like ordinary veneers, and left to harden. It hardens and takes a good surface. Any cavities that appear must be filled up with some of the composition mixed with oil of turpentine. The composition will keep fit for use for some time, if covered up with a damp cloth while moist. *Gewerbehalle, No.* 8, 1875, *from Akermann's Gewerbe-Zeitung.*

Staining in Imitation of Mahogany.—Soak 1 lb. of stick varnish in 2 quarts of water until all the colour is dissolved out; strain off the water, and add to the residue 2½ loths of powdered madder. Set the mixture over the fire until it is reduced to three-fourths of its original volume. Then mix together 2½ loths of cochineal, 2½ loths Kermes berries, 1 pint of spirits of wine, and ½ oz. of pearlash, out of which the colour has been washed by soaking in a gill of soft water. Add this mixture to the decoction of madder and varnish, stirring well together, and adding so much aqua fortis as will bring the red to the desired shade. *Gewerbehalle, No.* 8, 1875, *from Akermann's Gewerbe-Zeitung.*

Crumbling of Mortar.—The extent of contact-surface, and consequently the force of cohesion in cement may be increased in three ways :—by pressure from without, by increase in the value of single constituents, and by displacement of single constituents, produced by their solubility taken in connection with attraction and crystallization.

The first of these actions may be greatly facilitated by the workman with his trowel; the absorption of water and carbonic acid from the air produces an increase of volume, and the solubility of some constituents effects the transporting to places where the pressure is comparatively small, and where, on subsequent solidification, they bind the whole more firmly together. The second of these processes is the most important; but unless the proportion between the space left for expansion and the expansion itself be regarded, the mortar will not hold.

M. WOLTERS has made experiments with a cement in three different states of division. The most finely divided portion became hard most quickly, and in two days was at its best, then small cracks became apparent, and in eight days the mortar had fallen to powder. The middle sort was at its hardest in nine days, and had completely fallen to powder in four or five weeks. The coarsest powder hardened after eight weeks, and even after ten months did not crumble, but gradually lost cohesion.

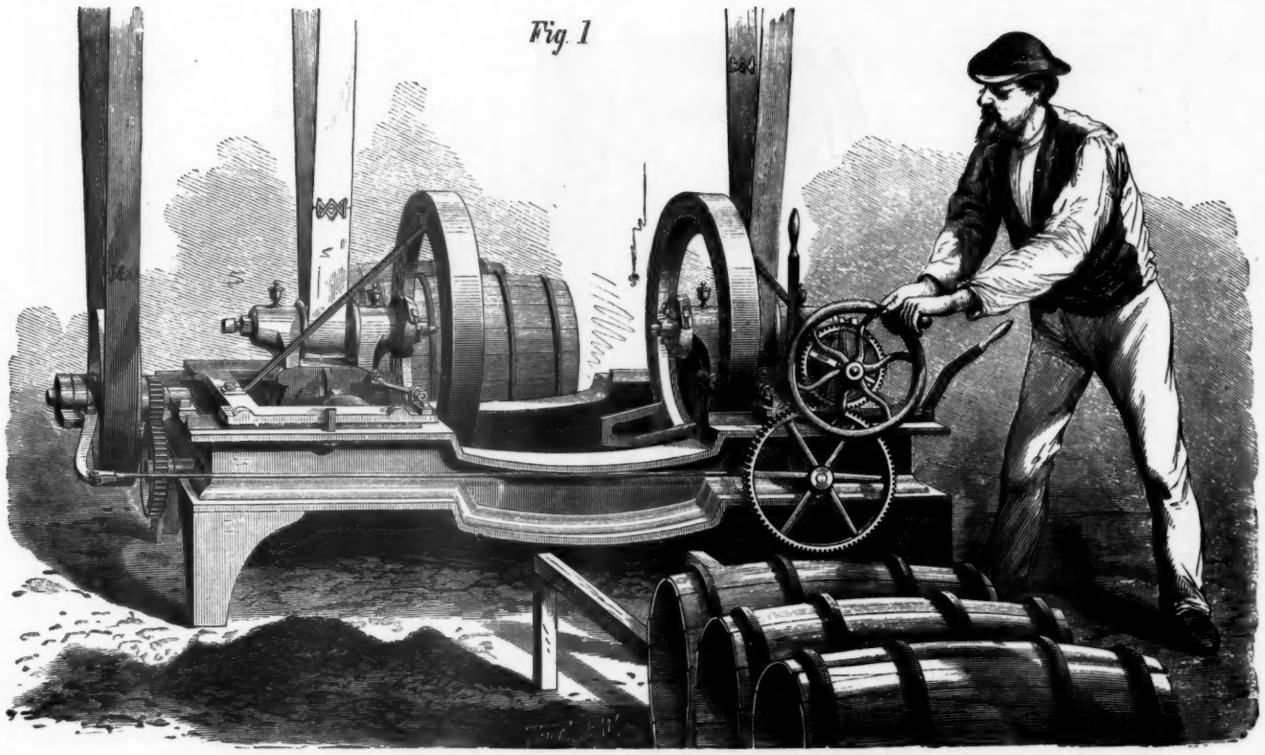
Too much lime in a mortar is said to diminish its cohesive power; also inequality in the grains, and too large grains. M. WOLTERS' experiments make it appear that no such effect is produced. The chief desideratum of a good mortar is that it shall rapidly become impervious to moisture on the outside. This is best fulfilled by Portland cement, which, in increasing in volume, becomes almost entirely indifferent to the action of carbonic acid and moisture. *Journal Chem. Soc., July*, 1875, *from Dingler's Polytech. Journal.*

HOLMES' IMPROVED BARREL MAKING MACHINERY.

OUR readers, and especially those interested in the manufacture of barrels, or who use the article to any great extent in their various callings, are doubtless aware that, not long since, strikes of considerable magnitude occurred among the coopers of this State. These movements owed their origin, among other causes, to the introduction into the market and use, by barrel manufacturers, of improved machinery by means of which the labour of skilled mechanics was, in a large measure, dispensed with, and the work readily accomplished by ordinary day labourers. The point maintained by the coopers was, first, direct opposition to the machines as a substitute for hand labour; but this position they afterwards abandoned, and fell back on the demand that they, and not men out of the trade, should be employed to run the shops. The question in some localities is still at issue; but in others, and especially in the manufactory which we recently had occasion to visit, the employers have prevailed, and are consequently carrying on their business with both a decrease in expenses and an increase in the quantity of their products. We allude to these uprisings, in the present connection, not to discuss their merits or demerits, but as a point of interest in reference to the machines represented in our engravings, which are the principal devices which have already caused in a certain degree, and we do not doubt are in the future destined to effect, an important revolution in the coopers' trade.

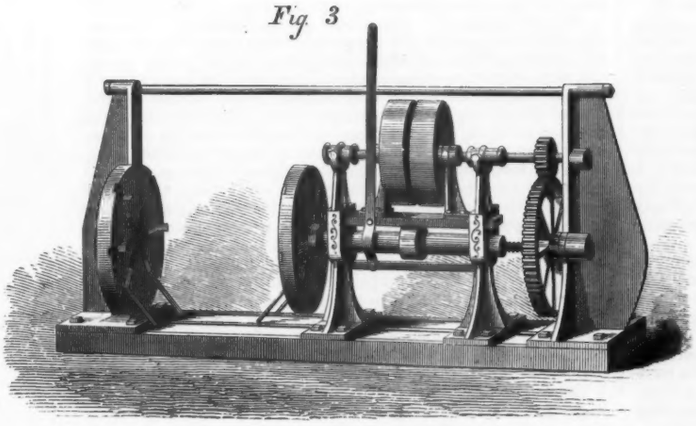
We recently devoted a few hours to the inspection of the barrel factory attached to the extensive sugar refining works of Messrs. Havemeyer and Elder, in Brooklyn, our object being to examine the operation of barrel making as performed by the machinery we are about to describe. With the superintendant of the establishment as a guide, we were conducted through various rooms heaped to the beams with thousands of bundles of staves and hoops, across courtyards, and, finally, into the long apartment which formed the principal shop. We cannot describe the noise which saluted us as deafening, for the word fails to express it; it was equal to that of a regiment of boiler riveters, and worse than a few dozen steam hammers, so that remarks of an explanatory nature were out of the question, or else were imparted by the aid of pantomime. Picking our way between belts, and dodging the barrels which were constantly flying about the room, we reached a space where loose staves were heaped, and where the workmen were busily at work setting up the barrels before delivering them to the machinery. The setting up form is composed of two heavy circles of iron, secured together and bolted to the floor; from these rise short standards which support a hoop. The staves are set in between the iron circles, and fitted carefully together. The iron truss hooks, which are previously placed in proper position, are lifted

Fig. 1



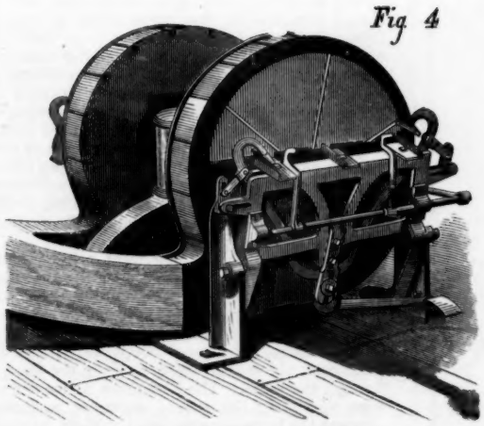
THE CHAMFERING AND CROZING MACHINE.

Fig. 3



THE LEVELLING MACHINE.

Fig. 4



THE STAVE JOINTER, WITH FAN.

HOLMES' BARREL MAKING MACHINERY.

Fig. 2.—THE TRUSSING MACHINE.

up by hand so as to embrace the lower portions of the staves and hold them in place, when the whole is lifted out of the frame. One half the barrel is now tightly held together, but the remainder was still open and flaring. To secure this in similar manner, a rope was passed around the flaring ends and taken to a hand windlass, a few turns of which brought the staves together, when the truss hoops were slipped over the extremities, and the barrel was ready to be heated in order to cause its staves to assume the curved shape. The heaters were simple iron cylindrical stoves, over which the barrel was set, the top of the latter being closed with a sheet iron cover, which was let down from above. Here the wood was well warmed through.

The levelling machine, to which the cask first passes, is a simple contrivance, the construction of which will be readily followed from our illustration (fig. 3), little explanation being necessary. Its object is to bring the cask into a shape that, when on end, it will stand in a perpendicular position and not lean in any direction. The barrel is placed between the two disks shown, where it is held by the projections on the inner faces of the latter. As we looked on, a workman moved the handle, a clutch was thrown into action, and the right-hand disk quickly advanced, powerfully compressing the cask. There was no blow or jar; and in less time than we have taken to pen the words the barrel was out of the machine, perfectly levelled and true. From three to four hundred casks per hour, we were told, could be thus manipulated.

Following our barrel, as it went rolling across the room, we next found it placed on end, and in the clutches of a number of hooked bars which protruded up through the floor, as represented in fig. 2. The longer arms just caught above the upper truss hoops, and sliding collars on them similarly caught on the second bands. The lower hoops were pressed against notched standards, which also stood up from the floor, but did not pass through the same. The long arms, as we came to the machine, were spreading themselves outwards and apart, and at this moment the barrel was inserted. Then, as they came together, they caught the hoops in the manner above stated, and pulled down, dragging the heavy iron rings over the more bulging portion of the cask, and of course wedging them on the more tightly. The same effect was produced by the stationary short lower standards, by their resistance to the lower hoops moving as the barrel was forced down. The simple mechanism which actuated this device, we found located in the cellar. It is a screw suitably connected with reversible gearing, the latter being governed by the lever handle shown in the engraving.

The machine, we noted, was operated by a single man and with great ease. A very strong power was brought to bear on each hoop, which thoroughly trussed the barrel with remarkable rapidity. We were informed that, although we saw it operating on slack work, which such as sugar barrels are termed, it was equally efficacious in trussing syrup or liquor casks or other tight work. It is easily adjustable, and hence is well suited for acting on barrels of different sizes, and will, we were informed, truss with perfect evenness from three to five hundred oil, or from ten to fifteen hundred sugar or flour, barrels in a day. The manufacturers claim that it will do the work of twenty men, and require little or no repairs.

The barrel, which we had followed through its various manipulations, now being levelled and trussed, was next passed to a machine which is unquestionably an invention of extraordinary merit and ingenuity. Our artist has represented it in fig. 1 as it appears in operation, the moment selected being that just after a finished barrel leaves and a rough one enters. If the reader will notice the three casks on the skids in the foreground, he will observe that the edges are irregular, due to the varying length, &c., of the staves. Now, before the heads are put in, each cask at each end must be crozed and chamfered; that is, a groove must be cut around the inside, a short distance below the edge, while the latter must be bevelled off. Besides, the ends of all the staves must be cut off perfectly true. Every one at all conversant with coopering understands that this work, when done by hand, is the most difficult and requires more time than any labour about the barrel; and this is even augmented when, in heavy casks, it is also necessary to cut a howel, or wide semi-circular indentation around just below the croze.

Some idea of the efficacy of the machine shown in fig. 1 will therefore be formed when we state that it chamfers, howels, levels, and crozes a cask of imperfect periphery with the same exactness as if it were a perfect circle, finishes both ends at once, and runs off from 800 to 1,200 barrels per day with ease.

The barrel passes from the skids directly between the chuck rings, and its ends fit into the peripheries of the cog wheels which work within the former. The workman, in our engraving, is shown turning the wheel, which, through suitable gearing, governs the backward and forward motion of the right-hand ring. The other chuck ring is stationary. As the barrel rolls into place the workman brings his ring up, thus confining it; then, by a pull of a lever, he throws a clutch into gear, which results in the rapid rotation of the barrel. Finally, by manipulating a third lever, he brings the cutters—which perform the above-mentioned operations, and which are all fastened on two circular heads, the shafts of which are mounted on vibrating carriages and revolved by the two smaller belts represented—up

against the inner edge of the barrel. One revolution of the latter and the work is done. The ring is drawn back and the cask rolled out, with the work of hours (by hand) finished in a few seconds. Each cutter head is controlled by a rest upon the outside, thus compelling a uniform thickness and depth of chime, while the same is levelled in a perfect manner. By proper-sized chuck rings, any kind of barrel may be operated upon, and the change from one size of ring to another is very easily effected.

From this point, we were told, the rest of the work upon the barrel is best done by hand. We saw the casks, as they left the machine just described, pass to an elevator, and thence to an upper loft, where an army of men were busily putting on the hoops, setting the heads in place, and otherwise completing the labour. Barrels differ so much in shape that it would be hardly practicable, it is said, to substitute machinery in this department; but to the casual observer it does not seem impossible, in view of so many ingenious devices having already been invented for work which, not long since, it was thought impracticable to accomplish save by hand. A glance into a great storeroom, revealing tier after tier of barrels (twenty-five thousand in all, we were told), completed our stay in this portion of the factory; and, descending to a lower floor, we were shown the device which forms the subject of our fourth figure. It is a combined fan and stave jointer, that is, it holds the staves firmly and cuts the joints on their edges, leaving each piece in the proper form to take its place in making up the barrel. It was used in the establishment which we visited to rejoint staves which had their edges split, or which otherwise were imperfect. Its principal advantage is that, in addition to occupying but little room, it gives off no dust or shavings to create nuisances in journals and boxes, or to afford ready tinder for the reception of stray sparks. All the débris is blown through suitable conductors to the fuel room. The apparatus works with great ease. When a stave is to be clamped, the stave holder is brought to bear upon it, and it is brought in contact with the jointer by the foot of the operator. As soon as the foot is removed, the clamp, by self-action, releases the stave, and is ready for another. A stave, it appears, cannot become loose or move until the clamp recedes from the cutters.—*Scientific American.*

THE PREPARATION OF "KIRSCHWASSER."

ALMOST every person who has travelled on the continent, and in Switzerland in special, will remember tasting the continental "kirschwasser," the preparation of which we propose to describe in the present article.

This beverage is prepared in the whole of the midland Swiss plateau, and in particular along the north side of the Alps and in the Jura Mountains. The best Swiss "kirschwasser" is produced in the Zug and Bâle cantons as well as in the Frick Valley. Although the common wood-cherry contains a large quantity of sugar, still it is never used in the preparation of "kirschwasser," for reasons that the fruit itself is too small and not sufficiently productive. On the other hand, the cherry mostly used is the sweet soft and red-stalked kind, and other blackish red qualities; the soft red cherries are also sometimes used, but the hard kinds are never gathered for this purpose.

The cherries are plucked as soon as they are fully ripe, thus enabling the gathering to be effected in a shorter time. Since it is thought that the cherry-stalks impart a disagreeable taste to the distillate, the stalks are left on the tree, and the further advantage is gained of so saving room in the cask. The plucking must take place in dry weather, for reasons that wet cherries are apt to spoil quickly, and the distilling product then becomes inferior both in quantity and quality. In most places where the preparation of "kirschwasser" is carried on, the cherries are made up in casks to ferment; but, strange enough, these casks after they have been used must not be thoroughly cleaned, but merely swept out with a brush. A company (the Zuger Kirschwassergesellschaft) has, however, begun to place the cherries in large cemented cavities, instead of in casks, and this method has proved itself very successful; the emptying and cleaning of these cement-holes requires great care on account of the carbonic acid which accumulates in these cavities, but which may be easily pumped out. During the fermenting process the cask or vessel must not be perfectly made up, in order to allow the carbonic acid to escape. At the commencement of this process, the fermenting cherries rise to the top, and form a cover over the accumulated cherry-liquid at the bottom of the cask; later on, this position becomes reversed, inasmuch as the cherries subsequently fall again to the bottom of the cask, and the liquid is then supernatant. When this takes place it is a sure sign that the process of fermentation is completed. The fermenting process is not of long duration, for in warm weather the violent escape of carbonic acid ceases gradually after a few days' action. As soon as the gas ceases to escape, the cask may be now firmly closed, if the distilling is to be postponed, as it usually is to the time when the farmer or peasant is not very busy—*i.e.* to the winter. The further advantage is hereby gained that the amygdalin of the cherry kernel becomes decomposed into oil of almonds and prussic acid by fermentation. It is to these substances that the "kirschwasser" owes its characteristic taste, and, in order to insure this savour, the cherry-stones are frequently crushed with special apparatuses. But this practice is to be avoided for reason that the fatty matter contained in the cherry-stone, and also decomposed by the fermenting process, is carried into the distillate. The purest and most agreeable "kirschwasser" would be doubtless obtained by the immediate distillation of the pure cherry-liquid, so possessing only the peculiar smell of over-ripe or preserved cherries.

The distilling is usually carried on by the peasants in copper vats with one or two vapour-pipe outlets. The boiler is not filled to the top so as to prevent its boiling over, and the firing must be slow, otherwise the contents become burned. Practice has also shown that, with slow firing, the taste of the "kirschwasser" is greatly improved. Quite as simple as this boiler is the condensing apparatus, which may be seen in rural districts to consist merely of a stone pump-trough in which inclined piping circulates. It is very essential that this cooling be done effectively, for otherwise the quality of the distillate will suffer. The first droppings are collected and returned to the boiler, so as to prevent such of the volatile particles as have escaped before the boiling of the mass remaining concentrated in one particular part of the "kirschwasser," and also to prevent the taking up of verdigris; for usually the first droppings have a fine skim on the surface which is composed of acetate of copper, and may be accounted for by the reaction of the atmosphere, the alcohol, and the little quantity of acetic acid contained in the "kirschwasser," acting on the inner surfaces of the cooling copper pipes. As soon as the distillate becomes weak, the remaining droppings are collected by themselves, and returned to the next filling of the boiler.

"Kirschwasser" is prepared in different strengths varying from 18° to 24° Cartier; it loses much of its heavy taste by keeping, and when kept for years it is said to drink "as milk," without, of course, having lost its strength. No doubt this is due to the gradual action of ozone. As to its quantitative production, it is reckoned that 100 lbs. of cherries will produce, according to quality, from one to one and a half gallons of "kirschwasser" of 20° Cartier.

MANUFACTURE OF SUGAR WITHOUT MOLASSES.—After a long and laborious course of experiments, M. LUIS JOUVEREY, a French chemist resident at Granada, has devised a method of fabricating cane-sugar without the formation of molasses. The process is described in a paper lately read before the Sociedad Economica de Amigos del Pais, at Granada, and will be reprinted in a forthcoming number of the under-specified journal. *El Porvenir de la Industria, 31st July*, 1875.

(We shall place a short summary of it before our readers when it comes to hand.)

Practical Literature.

CHAPTERS ON SOUND FOR BEGINNERS.[1]

THE impetus which has of late been given to the teaching of science, has called forth a multitude of elementary text books, good, bad, and indifferent. Many of these, though low in price, cannot be correctly described as "cheap," inasmuch as the information they contain is both inexact and incomplete, if not altogether erroneous. Others, again, arranged to suit the syllabus of one or other of the great examining

[1] *Chapters on Sound, for Beginners.* By C. A. Martineau. London: Groombridge and Sons.

bodies, are mere epitomes of larger works, and promote only that parrot-like knowledge which is so detrimental to the true interests of science.

To neither of these classes does the little work before us belong, but it affords an excellent example of what an elementary work should be. Written especially for juvenile students, it is free from that twaddling "goody-goody" style which so many writers seem to think the only fit medium of imparting knowledge to the young, and while every technicality is carefully explained, and every difficulty as far as possible removed, the style is not distasteful to a beginner of more advanced years than those for whom it is primarily intended. The manner in which the phenomenon of wave motion is explained forms a good example of this.

Another feature which demands special commendation is the stress which the author lays upon the necessity for individual experiment on the part of each student; and as the whole of the experiments mentioned in the work, with one exception, may be performed with no other apparatus than that which is easily accessible to most, it is to be hoped that the author's directions in this respect will be observed. The notion that science may be studied merely from a book, as we learn spelling or history, cannot be too strenuously opposed, and any work which assists in convincing the learner that he is now in a domain where each must for himself ascertain the truth or falsity of the statements which he hears is worthy of welcome and support. Altogether we can heartily recommend this work, feeling assured that, with the aid of a judicious teacher, a thorough comprehension of the rudiments of sound may be obtained by its study.

FAITH AND SCIENCE.[1]

THIS is a republication in French, in book form, of the speech of Mr. Tyndall delivered at the opening of last year's meeting of the British Association; of the speech of Du Bois-Reymond, on the Limits of Natural Philosophy; and of Professor Owen's speech last year at the Congress of Orientalists, on the Antiquity of Man. These speeches are followed by abstracts of the utterances of Professor Huxley, Dr. Hooker, and Sir John Lubbock, on Animal Automatism, Flesh-Eating Plants, and Wild Flowers and Insects. Excepting in the case of Professor Huxley, the source of the translation is not given. This French edition of these speeches is furnished with introductions and foot-notes by the Abbé Moigno, whose object in publishing these speeches is to refute them; or, as he says himself, in characteristically inconsequent manner, "Having heard the cry, 'Watchman, what of the night?'" has, with a valour and a sense of the fitness of quotation, worthy of Captain Cuttle, "taken from the brook of life the pebble of faith, and placed it in the sling of true science," and come forward "to pick up the glove thrown down by these Goliaths." The book is No. 45 of a series of "Actualités Scientifiques," consisting largely, we are pleased to see, of translations of various English works of science. It may stand among them, for the head is gold, though the feet are clay.

With the merits of the questions treated of in the book, we have little to do. The Abbé Moigno is well known and highly honoured for his long-continued efforts—long may they be continued—for the popularization of science, while his attachment to Catholic dogma is put beyond question by the notes in the present book. The service, too, which he renders to the cause of science in publishing these discourses is but little diminished by the pains he has taken to discredit them. The Atlantic *will* come in, in spite of Mrs. Partington; neither pope nor kaiser can keep the world, and all that it inherit, from recombination, and decomposition, and everlasting newness. Since this is so, it is a pity to see the abbé fancying that scientific deductions are to be exorcised with a text from Scripture, and, so far down in the nineteenth century, regretting the "ages of faith"—ages when Europe lay in bondage at the feet of selfish or vicious hierarchs, the victim of an ecclesiastical system more cruel and more deadly than plague or gangrene. In virtue of the humanity and science borrowed by it, or brought into it *ab extra*, the Church—wonderfully modified—still subsists. But the true Church, which shall not only give their proper direction to man's emotional qualities, but in the bosom of which shall be fostered the arts of progress and the means of the mastery of nature—such a church as the abbé feels is now laying its foundations.

The calm tone of the well-known speeches here reproduced is in very plain contrast with the liveliness of the abbé's annotations. The annotator depreciates the authorities, questions the statements, and rails at the deductions of the text, which he follows with a running fire of notes of admiration, texts of Scripture, small capitals, and impolite exclamations: "Ouf! quel galimatias! quel scandale! quelle hypocrisie!" are not arguments, though, perhaps, fit ingredients for the "sanglant démenti" of M. l'abbé. We may regret, too, the cynicism with which M. Moigno, speaking of Giordano Bruno (burnt alive by the Church for the crime of thinking for himself), says that "il succombe fatalement à la tentation d'aller dogmatiser dans sa propre patrie, et court au supplice *qui l'y attendait.*" Not a word of compunction for humanity's sake—not a word in disavowal of this deed of the Church *semper eadem*—that great enemy of our race, the Church of the Inquisition.

The good book of the good abbé will make no converts except from among the orthodox.

[1] *La Foi et la Science, Explosion de la Libre Pensée en août et septembre*, 1874. Discours annotés de MM. Tyndall, du Bois-Reymond, Owen, Huxley, Hooker, et Sir John Lubbock. Par M. l'Abbé Moigno. Paris, 1875.

AN INTRODUCTION TO THE USE OF THE MOUTH BLOW-PIPE.[1]

ALTHOUGH the use of the blow-pipe has been known to workers in various metals for several hundreds of years, it is only within the last two centuries that the instrument has been employed as an aid to scientific research, and it is scarcely more than fifty years ago that the attention of investigators was first turned to its application to quantitative analysis. From the beginning of the last century to the year 1821 it was employed solely for purposes of qualitative research. In recent years, however, "the use of the blow-pipe in qualitative and quantitative analyses has become so comprehensive in its details that considerable time and practice are requisite before the student can render himself master of the art, and this is especially the case with regard to quantitative assaying, which is in consequence seldom practised by chemists, but only by some few professional assayers in various parts of Germany."

The treatise before us, which, with the exception of a few paragraphs, consists of an almost literal translation of Professor Theodor Scheerer's "Löthrohrbuch," and a compilation from the works of Professor Plattner, von Kobell and Rammelsberg—the whole most carefully edited and verified, and supplemented by details from Mr. Blanford's own experience,—is intended to present a brief but comprehensive description of the most important processes of qualitative research with the blow-pipe. The work commences with a brief historical sketch, showing the means by which the instrument "has gradually attained to its present importance as an aid to the chemist, the mineralogist, the miner, and the smelter, in enabling them, by a short and easy process, to ascertain the chemical nature of the various substances submitted to them." It then gives full descriptions of the apparatus, and illustrations where necessary, with careful directions for its use in qualitative research; and, although of course only a practical experience can give the student the necessary skill in manipulating the instrument, yet these hints will be found of very great value and importance to him in commencing his investigation.

Tables are given showing the behaviour of "those mineral species which are of more frequent occurrence, or those which, being rare, present such well-marked characters as to render them good examples for practice." A very interesting series of special experiments is also given, in order to enable the student to establish with accuracy the presence of certain bodies, the reactions of which are more or less obscured by the presence of others.

We think the value of the work would have been enhanced if an alphabetical index to the subjects examined had been given, and we trust that in a future edition this will be added. The present edition, which is the third, has been carefully revised, and we can recommend the work as a cheap and concise handbook, valuable alike to the chemist, the mineralogist, the smelter, and the miner.

[1] *An Introduction to the use of the Mouth Blow-pipe.* By Dr. Theodor Scheerer; to which is added a Description of the Blow-pipe Characters of the more Important Minerals. By Henry F. Blanford, F.G.S. Third edition. London: Frederic Norgate, and Wilfiams & Norgate, 1875.